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DEVELOPMENT DIGEST

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A quarterly journal of excerpts, summaries, and reprints of current materials on economic and social development

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NUTRITION

CHILDREN IN GUATEMALA DRINK "INCAPARINA,"
A HIGHLY NUTRITIOUS DIET SUPPLEMENT.
(PHOTO: UNITED NATIONS)

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MALNUTRITION AND NATIONAL DEVELOPMENT

Alan D. Berg

[Malnutrition hinders development in a variety of ways, from mental and physical retardation to absenteeism. New methods of improving diets are being developed, but these can work only when governments realize the importance and face up to the magnitude of the problem.]

New evidence suggesting a relationship between malnutrition and mental retardation should be cause for major policy concern in a number of world capitals. It is now suggested that malnourished children may be basically dull. The significance of this can be appreciated when we recognize that as many as two-thirds of the children of most developing countries are suffering from some degree of malnutrition.

The insidious drain of malnutrition on national development takes other significant forms. Half the deaths in the developing countries occur among children under six years of age. The vast majority of these child deaths are attributed to infectious diseases which are relatively minor childhood ailments. The cause of death is not the infection itself, but usually the malnourished condition of the child when he contracted it. Malnutrition debilitates the body to such a degree that it is incapable of resisting what would otherwise be a passing infection. In a country like Ecuador, child death due to measles is more than 300 times greater (per thousand of population) than in North America. Whooping cough is still a major

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killer in much of the world. Similarly, such childhood diseases as chicken pox are often fatal because of the child's malnourished condition.

For a sizable portion of the survivors, malnutrition permanently retards physical growth. An increasing body of evidence now suggests a similar relationship between malnutrition in the early years and mental retardation. The result is an important and irretrievable loss of learning time during the most critical years of intellectual development. Some prominent nutritionists now suggest the damage may be irreparable.

What does this mean to national development? How much more productive is a properly nourished man? How much more will a man with full mental and physical capacities contribute to his society? Conversely, what are the costs to the society of malnutrition in the form of medical treatment, welfare-type relief and waste through death of those who have a limited number of productive years? What would be the cost/benefit ratio of a $10 million investment in food enrichment, for example, as compared to other forms of development expenditure, e.g., spending the $10 million for fertilizer or dams or roads or schools?

Unfortunately, little research has been directed to these questions. The scattering of peripheral studies, however, leads to certain inferences worth noting:

1. Limited life expectancy brought about by malnutrition limits the number of productive years. Recent calculations by Dr. Eugene Campbell show that the typical worker of Southeast Brazil will—because of improved health and resulting increased average life expectancy—produce nearly five times as much during his lifetime as the average person born in nutritionally deficient Northeast Brazil. Where malnutrition reduces life expectancy, the cost to society for education and other supporting expenses through the preproductive years becomes proportionately more costly per year of productive output.

2. Malnutrition decreases a worker's productivity. The body, weak from lack of proper nutrients, protects itself by avoiding the expenditure of energy. This results in apathy, lethargy, and lack of initiative. In the past, this apparent sluggishness was frequently attributed to laziness, indolence or other so-called "ethnic traits." The Food and Agriculture Organization (FAO) now reports that those countries with the lowest per capita daily protein (and caloric) consumption are also those with lowest productivity.

3. Malnutrition lowers a worker's resistance to disease and, relatedly, increases his rate of absenteeism from the job. Further, accident rates are higher among those who tire quickly due to malnutrition. A study of the old East African Carrier Corps reported that those laborers who supplemented their rations with herbs and green leaves showed a lower hospitalization rate—10 percent, compared to 40 percent for those who did not.

4. The medical costs necessary to treat the effects of malnutrition—either through hospitals or health centers—are many times greater than the cost of providing the necessary nutrients to prevent the malnutrition initially. One estimate, in Guatemala, is that 90 days of hospitalization for each case arising from inadequate nutrition costs $600, compared to $7 to $10 a year to prevent the malnutrition in the first place.

5. Certain nutritional deficiencies, such as acute vitamin-A deficiency which results in blindness, limit opportunities for productivity. In India alone there are at least one million preventable cases of blindness. For a few pennies a year, this blindness could easily be prevented.

The Philippine Government is attempting to pin a cost tag on its major diseases. It combines production loss, manpower fatality loss, cost of medical care and burial expenses. Using this calculation, total economic loss per year for beri beri, for example, is estimated to be more than 44 million pesos ($11 million). This is only for those cases reported or recognized. The late Dr. R. R. Williams, synthesizer of thiamine, reported:

> Deficiency diseases are extremely insidious in that they are sapping the vitality of Asians to an unknown degree. My conviction is that there are scores of millions, perhaps hundreds of millions, in Asia who are suffering from mild beri beri, and have done so for years, and they still do not know they have it.

Due to Dr. Williams' discovery, beri beri could be significantly controlled. Experimental enrichment of rice in seven municipalities in Bataan was responsible for a 76 percent to 94 percent decline of the disease.

A cursory look at some of the other literature suggests: In Newfoundland, compulsory enrichment of flour is credited with a striking 40 percent decline in infant mortality. In Madagascar, a sugar refinery is reported to have reduced the turnover rate of migrant labor from 60 percent to 6 percent by the introduction of a balanced cooked meal. In Costa Rica, a public works project showed over

three years an increase in work output—from 240 to 1, 157 cubic meters of earth moved per man per day—primarily as a result of improved sanitation and provision of substantial meals. Other studies in Uganda, Kenya, Brazil, and the old Belgium Congo indicate comparable results.

Protein and Grains

Although malnutrition is brought about by a number of dietary deficiencies, the most serious and challenging to scientists at the moment is the inadequacy of protein—the critical nutrient for both physical and mental growth. Protein need cannot be divorced from general food intake—but once the minimum number of calories is available to sustain life, it is the quality of the food which becomes all-important.

Dr. Aaron Altschul, the protein chemist, has calculated that more than half of the 80-odd million tons of protein consumed in the world every year is in the form of grain—not because grain is so high in protein (on the order of 10 percent) but because wheat, rice, corn, and other grains are consumed in such enormous quantities. If one could somehow enhance the protein quality of this grain, considerable progress could be made in the battle against protein malnutrition.

The value of protein in foods varies widely. It depends on a series of so-called "essential amino acids"—the value of the protein being only as great as the smallest of these. Envisioning this as a barrel, with a number of tall staves and one short one, the value of the total protein is only as great as the shortest stave. The rest is wasted. In the case of most cereal grains, this limiting amino acid is lysine.

In one of the most significant scientific discoveries of this generation, Dr. Edwin Mertz and his associates at Purdue University recently developed, through genetic selection, a strain of corn with a substantially increased lysine content. As a result, the protein value of corn can be nearly doubled—i.e., corn may provide a source of protein almost as good as milk. Presumably this genetic approach to protein improvement can be applied also to rice, wheat, and other grains. Tests are now being conducted in several countries to see whether such application is possible. It must be recognized, however, that even under the best of circumstances, the world is still a number of years away from growing a quantity of such high-protein seed.

Happily, a short cut may be possible—that is, by adding nutrients synthetically. The technology now exists to incorporate amino acids such as lysine during milling or by treating the whole grain. In processed foods, the system is even simpler.

Dr. Edwin T. Mertz, at Purdue University in Lafayette, Indiana, and an assistant, examine two rats used in a feeding trial with the new high-lysine corn (maize). The larger rat received the new corn, while the smaller rat was fed an ordinary hybrid corn.
(Photo: Purdue University.)

Other Protein Sources

A number of other possibilities are under study. Inexpensive oil seeds—such as peanut, cottonseed, chickpea, soybean, sesame, sunflower, and cocoanut—if processed and formulated into acceptable foods, could meet a protein requirement at considerably less cost than milk. (Milk is a luxury that most people in developing countries will not be able to afford for many years.)

After the oil is extracted from these seeds, little use is made of the residue for human feeding. Yet this material, properly processed, contains up to 50 percent good quality protein suitable for the human diet—particularly if combined with other foods. The cost of oilseed protein is well under one-fourth that of dry milk, and less than a tenth that of most other animal protein. The present supply of oilseed meal alone, properly processed, would be sufficient to meet more than twice the world's total protein deficit.

This oilseed principle has been employed by a number of companies in various countries to produce a variety of commercial, low-cost, protein products. The most successful of these is Vitasoy, a soy-based Hong Kong beverage sold in a typical soft-drink bottle and given a typical soft-drink promotion. Its sales keep pace with the major international soft drinks, and it outsells all others in the Hong Kong market. Certain conditions appear to be essential to the commercial success of such a product: it must be palatable; it must be inexpensive; it should be similar to products already known; it should incorporate ingredients that are locally available (or potentially so); it must be nutritionally potent.

Although this approach offers exciting possibilities, its significance should not be overestimated. The claim of some food scientists that this is the answer to the protein problem is perhaps a bit optimistic—at least for the present. Although the commercialized, formulated protein food can be of significant value to the urban poor, it offers less hope to the malnourished multitudes living in non-monetized rural areas.

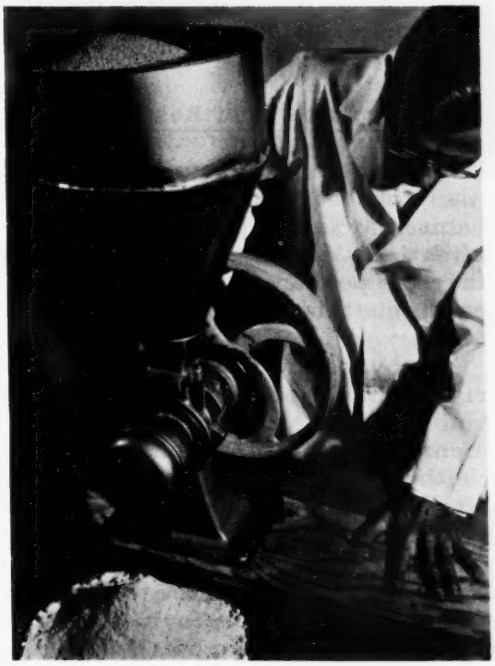
Recently much attention has also been given to fish protein concentrate, another good and inexpensive protein suitable for infants. Fish is the most underutilized conventional food source—accounting for only 1 percent of the world's total food consumption. Assuming that widespread cultural and religious taboos can be overcome, the use of fish in combating malnutrition has great potential.

A number of other protein discoveries have been made of late—some at this point laboratory curiosities—but their potential is too important to overlook. Receiving considerable attention is the prospect of producing edible protein by growing single-cell organisms on natural gas, petroleum, vegetable wastes or even coal. The Dutch Shell Group, for example, has found a bacterium which uses methane, a natural gas, as its sole source of energy for reproduction. These bacteria contain about 50 percent protein, and, according to U. S. nutritionist Dr. Nevin Scrimshaw: "There is little doubt that wholesome and nutritious single-cell products utilizing energy from petroleum or natural gas can be developed and produced in almost unlimited quantities within a decade." Some scientists are talking in terms of three to five years. Already, two million pounds of petroleum-based feed are being used to fatten cattle and poultry in a Russian research project. A similar "petroleum diet" experiment is being conducted with pigs in Nigeria.

The potential advantages are many: the relative abundance of petroleum, even in food-short countries; the independence from climatic uncertainties; the small space requirement; the need for only a few technicians; and the rapid growth rate. All these suggest the possibility of unlimited man-made protein production. Most of the world's large petroleum companies are deeply engrossed in protein projects. Some are actively collaborating with major food companies—such as the current Esso/Nestlé liaison. The president of Gulf Oil recently predicted the protein food will become a significant by-product of the oil industry.

Scientific imagination has gone further. "Milk" has been produced from water-soaked leaves. Seaweed and algae are other protein possibilities currently being examined. (A French company recently discovered an entire West African village successfully using

Right: A machine, which looks like a coffee grinder, takes dehulled soybeans and grinds them into flour; the final phase in a five-step process to produce a nutritious, high-protein soy flour. (Photo: Agricultural Research Service, U.S. Department of Agriculture.)



Left: A protein-rich dietary supplement produced from petroleum is scooped from a drying jar. (Photo: Gulf Oil Corporation, Pittsburgh.)

Right: The three stages of fish protein concentrate (FPC): the fish; the raw fish in ground-up form; and the flour, which will supply a protein-rich concentrate to be incorporated in foods. (Photo: Bureau of Commercial Fisheries, U.S. Department of the Interior.)

algae as its basic protein source.) Much work remains, however, to improve palatability and to find ways of producing economically feasible products.

Applying Results of Research

Required changes of food habits, indispensable to the success of many of the above approaches, present an imposing obstacle. Food habits have deep psychological roots and are associated with love, affection, warmth, self-image, and social prestige. As a result, there is perhaps no aspect of personal life less flexible than one's eating pattern.

To bypass what Dr. Margaret Mead refers to as "the irrational rigidity" of inadequate diets, one might conclude that, when possible, emphasis should be placed on food fortification and the development and multiplication of new varieties of high-protein seed. Neither the color, texture, nor taste of the food need be affected. Similarly, no change would be required in existing buying, cooking, or eating habits.

This does not eliminate the need for other approaches or for a strong educational effort. In Africa, for example, some believe that mangoes produce jaundice. In India, one of the few foods accepted throughout the country is dal, very high in protein, but rarely fed to the weaning infant because of unfounded fears that it will cause digestive problems and eventual death. In this instance, the necessary protein to keep the child healthy is literally in the mother's

School children in the state of Madras, India, enjoy a nutritious meal made of a mixture of high protein grains and hot spices.
(Photo: Carl Purcell, U.S. AID)

possession. Yet dal typically is fed only to adults of the family—even though the protein requirements of the infant are two and one-half times greater per kilo of body weight.

The large programs of child feeding now under way in most developing countries are themselves helping to improve standards of nutrition—but many believe they could be accomplishing more. Unfortunately, such programs frequently connote relief or charity. As a result, the food is usually provided as an end in itself, rather than to accomplish other important goals—viz. intentionally reorienting eating habits, incorporating nutrition education into the curriculum, encouraging the use of local commodities, and helping to establish the necessary agencies to continue a program after current sponsors no longer are involved.

Although most of the necessary resources to combat malnutrition may be readily at hand, the solution to this problem is by no means simple. Unlike the successful program to eradicate malaria, more than a can of spray is needed to conquer this more pernicious enemy. Malnutrition is a multifaceted problem requiring a coordinated approach. While promising nutrition activities are taking place in a number of countries, the accomplishments so far fall considerably short of the need. Technologically, malnutrition can be overcome. The arduous and expensive task of doing it has hardly begun.

The basic fact, perhaps, is that governments which have discussed the need in principle have not faced up to the magnitude of their role. Although governments recognize that an educated populace is important for development—and hence give substantial support to educational systems—there is not yet the same awareness that a well-nourished population has comparable importance. Perhaps this lack of governmental focus on the importance of nutrition for national growth reflects only an information gap between the laboratory and the political leader that will be overcome in time. Meanwhile, the consequences for national development are increasingly clear.

[Condensed by special permission from Foreign Affairs, Vol. 46, No. 1, October 1967, pp. 126-136. © 1967 by the Council on Foreign Relations, Inc., New York.]

AMINO ACID FORTIFICATION OF STAPLE FOODS

Daniel Rosenfield

[Raising the protein contribution of familiar staple grain foods by amino acid fortification, which does not alter taste or appearance, is an economical method for combating malnutrition and one that is gaining interest in the developing countries.]

Large segments of populations receiving the major portion of their daily calories and protein from one or two sources of cereals, legumes, and/or starchy foods suffer protein malnutrition which is particularly harmful to children in the one to five year range. If the major components of the daily diet are fruits and starchy foods such as cassava and plantain, then the first priority is to add protein to the diet regardless of its biological value. In this case, fortification with amino acids is not relevant, for fortification connotes upgrading the quality of existing protein. Obviously, if there is little, if any, protein in the diet, there is no point in considering amino acid fortification. Addition of protein concentrates to these protein-free diets makes sense, but in accepted usage of the term this is not protein fortification.

In most developing countries, primary sources of calories and protein are cereals—wheat, rice, and corn. Usually, for any one country or area within a country, there is dependence upon a single cereal as the staple of the diet with concomitant protein malnutrition. Even in sections where more than one cereal and also legumes are consumed, the problem is still present. In theory, it is possible for cereals and

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legumes to have amino acid patterns which complement each other to upgrade the total protein quality. But, the concurrent availability of complementing crops within a specific region occurs irregularly in real life. This point cannot be overemphasized. Since there is worldwide dependence upon cereals, it is important to improve the protein quality of these staple crops and the processed foods derived from them.

Approaches for Improving Protein Quality

Genetic manipulation. The first approach is to develop cereal varieties higher in both protein quantity and protein value. An example is the so-called high-lysine corn.

Fortification with protein concentrates. A second approach is to add protein concentrates from sources such as fish, cottonseed, soybeans, and peanuts to cereal-based foods. This is desirable as the protein quantity as well as quality is increased. However, use of these concentrates is feasible only where the types of foods which are commonly consumed would allow such concentrates to be added without alteration of the flavor, texture, and appearance expected by the people. It should also be kept in mind that amino acids can improve the protein quality of these concentrates; such nutritional improvement would help to increase the use of concentrates.

Fortification with amino acids. A third approach to raising protein quality of food staples is fortification with amino acids. The nutritional benefits of amino acid fortification have been well documented, and, since it does not change a food's appearance and eating characteristics, it will not require changing traditional food habits.

Cost-Benefit Factors

For 9/10 of a U.S. cent the total protein value of one pound of bread can be increased 16 percent by the addition of 4 percent of skim milk powder to wheat flour. The amino acids of milk protein complement the amino acids of wheat protein and thus the biological quality of wheat protein is increased. The total protein value of bread can also be raised by addition of the amino acid lysine to wheat flour. The fact that wheat flour is deficient in lysine limits the biological utilization of wheat protein. For 3/10 of a cent, which is 1/3 the cost of milk powder addition cited above, the total protein value of bread can be increased by 38 percent by addition of 0.3 percent lysine to wheat flour (more than twice the effect of the milk powder). Comparable benefits for soy flour and fish protein concentrate (FPC) are as follows: 4 percent soy flour (50 percent protein) will increase total protein value by 23 percent at a cost of 3/10 cent per one pound loaf. With 3 percent FPC there is a 33 percent increase at a cost of 1 cent.

Table 1. —Results of Fortifying Grains with Lysine and Other Protein Boosters

A. Fortification with Lysine Only:

Grains	Optimum % of L-lysine HCL to be added	PER* Fortification Before	PER* Fortification After
Whole Wheat	0.1	1.3	1.7
(Wheat Flour)	0.25	0.7	1.6
Rice	0.1	1.5	1.8
Corn	0.05	1.5	1.8
Millet	0.2	0.7	1.8
Sorghum	0.2	0.7	1.8

B. Fortifying Bread with Various Supplements:

Supplements	PER*	% Protein in Bread	Net % Protein Value
None	0.9	15	7.3
0.3% L-lysine HCL	2.2	15	10.0
3% Fish Flour	1.4	17	9.0
3% Fish Flour and 0.4% L-lysine HCL	2.7	17	12.9
16% Toasted Soy	1.8	21	13.0
16% Toasted Soy and 0.5% L-lysine HCL	2.7	22	16.7
25% Non-fat Dry Milk	1.8	17	11.8

*PER: Protein Efficiency Ratio - grams of weight gained divided by grams of protein consumed; rat feeding study.

Note: Net protein value is determined by both the percentage of protein in the grain product (e.g., bread) and by measurements of the biological utilization of this protein. Several different formulas may be applied for converting PER figures into net protein percentage figures, depending on definitions of protein utilization.

Sources: A. Dr. E. E. Howe, Quinton Company, Rahway, New Jersey
B. Dr. G. R. Jansen, Merck and Company, Rahway, New Jersey

Fortification with amino acids or protein concentrates are not mutually exclusive. For example, 0.4 percent lysine and 3 percent fish flour give a higher biological value than 6 percent fish flour alone. Table 1 shows results of grain fortification with lysine alone, and with other protein supplements.

The raw materials for lysine manufacture, either by chemical synthesis from certain petrochemicals or by microbiological fermentation of waste carbohydrate materials, are readily available, relatively inexpensive, and are unlikely to fall short in meeting foreseeable demands. Lysine is also the most strategic of the amino acids for fortifying staple grains, as it is the initial limiting factor to effective protein utilization. Other, more expensive, amino acids (tryptophan and threonine, as shown on Table 2) are of less value unless lysine has also been added.

Table 2.—Costs of Cereal Fortification with Amino Acids

Cereal	Cost per Metric Ton
Wheat flour + 0.2% L-lysine	$ 4.40
Whole wheat + 0.1% L-lysine	2.20
Maize + 0.1% L-lysine	2.20
Maize + 0.3% L-lysine + 0.07% DL-tryptophan	13.61
Milled rice + 0.05% L-lysine	1.10
Milled rice + 0.1% L-lysine + 0.05% L-threonine	10.45

Actual costs:	
L-lysine	$1.00 per pound
Assumed costs:*	
L-threonine	$7.50 per pound
DL-tryptophan	4.54 per pound

*Assumed costs of production for minimum of 10 tons per month. Commercial demand does not now justify this level of production.

Fortification Programs

Amino acid fortification is used in conjunction with other nutrients in newly developed foods [see pp. 17-19] and in established foods in some Western countries. Fortification of staple foods like wheat, rice, or corn is at an initial stage in the developing countries: Peru is in the process of implementing a decree of May, 1968, which asserts that "protein enrichment or lysine enrichment of popularly consumed grains and their derivatives is of social interest and

national necessity;" Indonesia is considering compulsory fortification of its wheat imports; Pakistan is studying the question of fortification; the Philippines is looking into the addition of lysine to monosodium glutamate which is widely used to sprinkle on rice; India is exploring various kinds of fortification. Interest is rising, and there is a widespread feeling that fortification of staple foods with amino acids and/or protein concentrates is a method which can benefit the largest number of malnourished people in the shortest time.

A number of research projects are currently underway which relate to this question. Most are under clinical conditions or are small in scale; of particular interest is a program in Tunisia, expected to begin in early 1969, which will employ selective fortification of wheat on a large scale under real life conditions. In a dry area where wheat is the major source of proteins and calories but where virtually no local wheat is grown, the wheat shipped in from the north through normal commercial channels will be treated for three different subareas as follows: 1) with lysine and other nutrients; 2) with other nutrients only; and 3) with no additions. The program will run for three to four years, and its results should be of major significance.

[Excerpted from a statement to the Caribbean Seminar on Protein Foods, Georgetown, Guyana, 29 July - 2 August, 1968; with supplemental materials by the author.]

THE DEVELOPMENT OF NEW PROTEIN FOODS

Aaron M. Altschul

[In the last few years a number of new high-protein foods have appeared in developing countries and some have proved highly successful commercially. A U.S. Agency for International Development program is encouraging further such developments.]

Two recent developments in new foods—a bread and a beverage—are already making an impact on diets. One of these, "Modern Bread," is illustrated on the next page, in an advertisement from a Bombay newspaper.

The Indian Government is establishing modern bakeries in its major cities with the aid of Australia and Canada, under the Colombo Plan. Six are already operating and others will be opened soon. Bread from these bakeries is fortified with vitamins, minerals, and lysine. The government subsidizes the cost of fortification with vitamins and minerals. Twenty tons of lysine for the initial fortification has been supplied as a grant from the Dutch Government. The eventual production goal is 100 million loaves yearly.

This, in itself, is a very small addition to Indian nutrition, but the bread is sold out daily and is becoming an established market item. It is being repackaged by some entrepreneurs and sold by the slice. More important, competitors are now fortifying their bread.

Dr. Altschul is Special Assistant for International Nutrition Improvement, Department of Agriculture, Washington, D. C.

FROM
BOMBAY, INDIA
1968
MODERN
BREAD
MBI
A VERY SPECIAL
NEW YEAR'S GIFT
FOR YOU!
MODERN
BREAD IS HERE!
Fortified with Lysine*! Enriched! Vitaminised!
Modern Bread is now available in Bombay! Made from carefully
selected ingredients in an automatic bakery, Modern Bread is rich in
vital Proteins, Vitamins and Minerals! It comes to you oven-fresh
every day, sliced and wrapped in stay hygienic, soft and fresh all day!
Go for the bread in the blue and purple striped pack!
It's reasonably priced. It's good!
Get a loaf today!
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MODERN BREAD—Good for both—health and growth!
MODERN BAKERIES (INDIA) LIMITED,

The second major development this year is the commercial test marketing by the Coca-Cola Company of a chocolate-flavored soybean beverage called "Saci" (pronounced saw-see) in the Rio de Janeiro area. This beverage, with three percent protein and added vitamins, is stable without refrigeration, and has shown good acceptance in its first test month. It may have the commercial potential of "Vitasoy," which already commands 25 percent of the soft drink market in Hong Kong, and can be credited with stimulating much interest in new commercial protein beverages.

We may look upon the development of new protein foods in terms of four generations.

The first generation was non-fat dry milk, distributed in large quantities shortly after World War II. A commercial product, it was used widely.

The second generation came when the milk supply was reduced. Then Incaparina, a plant protein food comparable to the dry milk, was designed primarily for its nutritional impact [see Development Digest, October 1966]. Similar foods designed on that basis were Pronutre of South Africa; CSM, a mixture of corn-soy-milk which

is part of the U.S. Food for Freedom Program; and Bal Ahar, a vegetable protein mixture, designed particularly for India. Two other foods of this type were designed for Lebanon and Haiti.

A third generation might be foods designed primarily for acceptability but nevertheless nutritious. Such foods would be the beverages Vitasoy and Saci, a new baby food in India, the new beverages Puma for Guyana and Frescavida for El Salvador, or the fortified noodles designed for Tunisia.

Finally, a fourth generation might be acceptable foods whose nutrition may further be improved by changes in composition, such as the Modern Bread of India which is improved by fortification.

A program is being developed and financed by the Agency for International Development to encourage private American food companies, with the desired technical capabilities, to investigate the possibilities of developing new foods in protein-deficient countries. The experimental three-year program calls for about six companies to be financed in each year. The companies involved the first year were Pillsbury (protein beverage for El Salvador), Monsanto (soybean beverage for Brazil), Swift (soybean foods for Brazil), Krause Milling (fortified corn food for Brazil), International Milling (high-protein wheat foods for Tunisia), and Dorr-Oliver (cottonseed protein concentrate for India). An equal number, or perhaps a few more, are being considered for 1968. There seems to be no question of having enough commercial interest to complete this program. We are now approaching the next stage in developing new commercial foods: consideration of investments in new facilities to manufacture some of the models developed in the first year.

[Excerpted from remarks presented to the 2nd Joint Meeting of the American Institute of Chemical Engineers and the Instituto de Ingenieros Quimicos de Puerto Rico, Tampa, Florida, 21 May 1968, pp. 13-27.]

INFANT MALNUTRITION AND ADULT LEARNING

Nevin S. Scrimshaw

[Recent investigations into the relation of childhood nutrition with brain development indicate malnutrition as one of the factors affecting test performances in learning ability and intersensory integration.]

Early malnutrition sufficient to impair physical growth in experimental animals has repeatedly demonstrated its effect on their subsequent learning, memory, and adaptive behavior.

In the rat, 80 percent of brain growth occurs by four weeks of age; in the pig, by eight to ten weeks. The total body weight of both at these ages is less than 20 percent of their usual weight at maturity. Rats which are underfed in the first few weeks after weaning and then placed on an adequate diet have smaller brains at maturity than control animals. Since the brain is growing so much faster than the rest of the body during these early weeks, the result of early undernutrition is a brain which is abnormally large for the body weight but small for the age of the animal.

In the child, the brain achieves 80 percent of its adult weight by age three, while the body reaches little more than 20 percent of adult weight. The child's first three years of development are thus comparable to the first four weeks in the life of a rat or eight to ten weeks for the pig. At birth the human brain is gaining weight at a rate of one to two milligrams per minute. It could be expected, therefore,

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that protein deficiency serious enough to limit gain in height and weight during the first two to three years of life can also limit brain growth. While head circumference is of no value in predicting normal variations in intellectual capacity, it is a useful—if not absolute—indicator of brain size. When children are undernourished at an early age, their brain growth, as judged by head circumference, is significantly less than that of well-fed children.

Beyond about three weeks of age for the rat and five weeks of age for the pig, the effect on brain size of short periods of undernutrition becomes progressively less pronounced. The adult brain is remarkably resistant to changes in body weight, even during severe starvation, provided it is able to grow normally to a mature size before the starvation begins. Prisoners of war and concentration camp internees in World War II who survived long periods of severe food restriction showed no loss of intelligence after rehabilitation.

In experimental animals, central nervous system damage is pronounced on a diet deficient in protein but adequate in calories. When Dr. R. J. C. Stewart, Dr. B. F. Platt, and collatorators at the Human Nutrition Research Unit of the National Institute for Medical Research, Mill Hill, in London, fed diets severely deficient in protein though adequate in calories to weanling rats, piglets, and puppies born of well nourished mothers, the animals exhibited signs of central nervous system damage. Electroencephalograms showed diminution of rhythmic activity, and degenerative changes were found post-mortem in the nerve cells and neuroglial cells of the spinal cord and brain medulla.

Similarly depleted animals were subsequently fed a high-protein diet for one to three months, and their clinical condition improved promptly; but again, when these animals were examined post-mortem, cells in the central nervous system were still obviously damaged. The severity of such changes was increased by lowering the age at which the deficiency was established, by further reducing the protein value of the diet, or by increasing the duration of the deficient diet.

In the studies of the Mill Hill group, in which the diets of the animals during pregnancy were deficient in protein and the animals' offspring were fed deficient diets after weaning, the effects were similar but even more pronounced. Dr. Bacon Chow at Johns Hopkins University and Dr. Sanford Miller at the Massachusetts Institute of Technology (MIT) have observed that young rats born of malnourished mothers show behavioral changes when they continue to be fed by their mothers. Dr. Miller has demonstrated that these effects can be avoided if the young are transferred at birth and suckled by a well nourished mother.

At the University of Aberdeen in Scotland, Dr. John Cowley found that a low-protein diet fed in unrestricted amounts to rats after weaning had no effect on their problem-solving ability in a maze. But the progeny of these rats, also maintained on such a diet, showed markedly reduced intelligence by the same test, as did second- and third-generation rats continued on this protein-deficient diet.

Participants at the International Conference on Malnutrition, Learning, and Behavior, held at MIT in 1967, and at the 1964 international meeting in Washington, D. C. on Preschool Child Malnutrition, presented data from more than forty developing countries, illustrating widespread growth failure among young children. Genetic differences appear to be of minor importance in accounting for these findings, for children of middle- and upper-income families who are well fed in the developing countries generally share the growth patterns of children in Europe and North America. Whether the racial composition of the more privileged groups within a country differs from that of lower-income groups or is identical, the less privileged children fail to grow as well. Retardation in growth and maturation due to malnutrition is common among preschool children in nearly all of those countries considered to be technically underdeveloped. Some particularly underprivileged groups in industrially advanced countries would be included as well.

The most serious complication in designing field studies of these problems is that social and psychological factors may independently have the same adverse effects as malnutrition on learning and behavior and on the anatomical and biochemical development of the brain. Studies with rats, kittens, and monkeys have clearly indicated that animals which are protected from stimulation and prevented from exploring their environments have not only smaller brains with fewer nerve cells but also develop functional impairment of the central nervous system.

Similarly, institutionalized children, well fed and genetically normal but deprived of affection and stimulation at an early age, may show marked mental impairment. The many kinds of psychological and social deprivation common among malnourished children can exert a direct effect on intellectual performance. Unstimulating home environment, poor educational facilities, isolation resulting from illness, limited recreational opportunities, and lack of incentive due to repeated discouragement are examples of such deprivations.

Very few long-term field studies in human learning and behavior have been completed, and most have failed to separate adequately the effects of malnutrition from those of other environmental factors. The information gathered in the town of Tlaltizapán, Mexico, by Dr.

Joaquin Cravioto, Dr. Rafael Ramos-Galván, and their collaborators, is the outstanding pioneering effort in this field. Because the economic, educational, and social status of families in Tlaltizapán was very uniform, these factors were judged to influence the variation within the study population to a lesser degree than the differences in nutritional status.

Retardation in physical growth and development was found to depend upon family dietary practices and on the occurrence of infectious disease. It was not related to differences in housing facilities, personal hygiene, proportion of total income spent on food, or other indicators of social and economic status. Under these circumstances, the investigators found test performance of preschool and school children to be positively correlated with body weight and height.

In order to extend these studies to another population and also to make more prolonged observations, Dr. Cravioto and several members of his team joined forces with the Institute of Central America and Panama (INCAP) in Guatemala. They selected school-age children living in Magdalena Milpas Altas, Guatemala—a predominantly Mayan Indian village of 1, 600. Variations in height and weight among the children of this community were not related to height of the parents or to the minor differences in economic and social status among families. The major reasons for short stature was malnutrition at an early age. Two years of intensive work in this village showed once again that retardation in height for age relative to other children in the village was accompanied by poorer performance on psychological tests.

A growing body of evidence indicates that primary learning and the development of adaptive capacity is based on the development of interrelation among the separate senses. During ages six to twelve years, intersensory relationships follow a well-defined growth pattern in normal children. Dr. Cravioto gave principal emphasis, therefore, to tests of intersensory integration. The tests involved manipulating eight differently shaped wooden blocks. The examiner determined visual integration by asking the child to put the blocks into their corresponding holes as rapidly as possible. The integration of visual stimuli with the complex sensory input required by active manual manipulation of a test object was judged by asking the child whether a block placed in his hand behind a screen was the same or different from one in front. Kinesthetic-visual integration was measured by moving the child's hand behind the screen to trace a shape which he had to judge to be the same or different from that of a block in front of him.

Each of these types of intersensory relationship improved with the age of the child. This was true for both children of the study

village and those from middle- and upper-income families in Guatemala City. The rural children clearly lagged in the development of intersensory competence when compared with the privileged urban children. Of even more significance, the relationship between poorer test performance and shorter physical stature in the rural village did not apply to the well nourished urban children. Among the urban children there was no correlation between the height of the child for age and test performance.

Dr. Cravioto returned to Mexico and obtained similar information on intersensory integration among school children in Tlaltizapán. He found that here, as in Guatemala, the smallest children in the village show poorer intersensory integration for their age than those who are tallest. Among children of upper-income families in Mexico City, no such correlation exists. Clearly, where the child is more nearly able to realize his genetic potential for growth, differences in height lose their nutritional and social significance.

It is clear that under circumstances common to developing countries, malnutrition can interact with infection, heredity, and social factors to bring about physical and mental impairment. The social factors responsible are multiple and difficult to correct, but the elimination of malnutrition and infection among underprivileged populations is a feasible goal.

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CALORIES AND PRODUCTIVITY IN ASIAN COUNTRIES

Harry T. Oshima

[Increased calorie intake would make a more than proportionate contribution to a man's working potential in Asian countries, where present average calorie intakes are low and tend to be associated with low productivity.]

Actual daily calorie intake figures for Asia, where available, appear to range from 1,900 to 2,100 for countries with non-Chinese populations and about 2,300 for Taiwan and Malaya-Singapore. This difference is probably due to the larger body size of Chinese and their higher activity levels in Taiwan and Singapore-Malaya. These per capita per day calorie figures are averages for the entire nation. They gloss over wide variations between different income groups, between seasons, and between regions. Available data from scattered surveys tend to show that the variations are extensive, and it is in these variations that one detects a condition of insufficient calorie consumption for optimal work effort in most parts of Asia. For example, data for Maharastra State (1958), India, in the 1963 Food and Agriculture Organization (FAO) Third World Food Survey show that the lower income groups were consuming only about 1,500 calories per day per person compared with 2,300 for the middle income and 2,900 for the higher income groups.

According to one FAO report on calorie requirement:

> Experience shows that human beings have a remarkable capacity for adjustment to

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restricted calorie intakes. This is to some extent the result of physiological adjustments, for example, in the form of low body weight and low basal metabolic rate. Social adjustment is, however, perhaps even more important in such circumstances. The whole manner of life is adapted to an insufficient supply of calories, with results that are socially undesirable: lack of initiative; avoidance of physical and mental effort; excessive rest.

In rural areas of Asia, insufficiency of calories may take the form of inadequate work effort after the peak seasons. During harvesting periods, peasants work long hours (12 to 15 hours) and eat four to five meals; during such times their consumption of calories may come up to 4,000 a day. But for the rest of the year, calorie consumption may not be enough, for example, to weed adequately the crop in the field; or more important, as the food supply dwindles with the passage of time, calorie consumption may fall so low that enough energy cannot be expended to put in another crop of rice or vegetables for the remainder of the year, or perhaps to work in the nearby towns or cities. Unfortunately, the surveys of food consumption do not give information on calorie consumption for different seasons of the year. But with annual calorie consumption around 2,100, an intake level of 3,000 during the busy months would imply levels of 2,000 to 2,500 during moderately busy months and 1,500 to 1,800 during slack seasons, given seasonal peaks and troughs of agricultural activities in most Asian countries.

Taiwan has the highest per capita consumption of calories in Asia, about 2,400, which is about 15 percent higher than other Asian countries, as estimated by FAO. This average is largely due to the extensive multiple- and inter-cropping carried out by the Taiwanese peasants. According to S. C. Hsieh (now with the Asian Development Bank) and T. H. Lee of JCRR [Joint Commission on Rural Reconstruction], the multiple-cropping index has risen from 132 in 1931-35 to 180 in 1956-60. Labor input in the earlier period averaged 220 days, and in the latter 305 days. For other countries of Asia, with the exception of Japan and South Korea (with indexes of 159 and 155, respectively), the multiple-cropping index is low. The index for the Philippines is 127; for Pakistan and India 114; for Ceylon 111; and for the others below 110. The association of low calorie intake with a low multiple-cropping index, though imprecise, is suggestive.

The impact of food deficiencies on urban work is discussed in another FAO publication, and the following is one of the examples given: thirty German railway track workers were able to increase the tonnage of earth moved from 1.5 tons with 2,300 calories to 2.5 tons with 3,000 calories. Other examples deal with industrial workers in Europe, Africa, and the Middle East. An interesting aspect of

FAO's illustrations of added output resulting from increased calories is that the increases in the former were greater than the increases in total calorie intake. In the case of the German railway workers, the output rise was 67 percent with an increase in total calories of only 33 percent. We may explain this as follows.

A large part of the total annual calorie intake of a person is similar to the overhead costs of a business enterprise. It does not vary with work activity. This constant portion of calorie intake is needed for the basic metabolic functions, irrespective of whether a person works 24 hours per day or merely sleeps 24 hours per day. For the average adult male Asian, these calories amount to about 1,500 per day, roughly 1 calorie per minute. Another category of calories may be said to be approximately invariant to the degree of work activities, and this is for personal, domestic activities (i.e., washing, dressing, etc.) and for recreation, which may amount to about 100 to 200 per day. If we assume that the average adult Asian male consumes 2,500 calories per day, then over one-half of this may be considered overhead calorie cost, necessary to keep the human body alive 24 hours. The rest is available almost entirely for energy needed to perform work activities. In this situation, a 20 percent increase in total calorie intake to 3,000 would increase the capacity to work by more than 40 percent.

Asian peasants have been able to till the same soil for several thousand years primarily because the nutrients taken out of the soil by food plants are returned to it as plant food in the form of animal manure and human excreta. If to this endless cycle of nutrient circulation is added artificial fertilizer for multiple- and inter-crops, the cycle will be an enlarged one, and if population does not rise in proportion with additional fertilizer, the nutrient passing through each worker will be a larger one, enabling him to put forth additional energy. The increasing nutrient passing through man and soil each year can constitute a cumulative upward spiral. Here the expenditure on artificial fertilizer and more calories per capita may be regarded as capital formation, as permanent as any concrete structure.

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COMBATING MALNUTRITION: A WORKING MODEL

Alan D. Berg and F. James Levinson

[The Government of India has developed a comprehensive nutrition plan, the first of its kind, estimating the deficiencies of a critical population group and the costs of remedying these deficiencies by alternative methods.]

While the world food problem is still thought of primarily as one of agricultural production, there is today increased consciousness of what might be labeled the qualitative side of the food problem. A number of articles, monographs, and scientific reports written of late have posed this "quality" factor as a vital requisite—along with agricultural production (the "quantity") and population control—to any program seeking to successfully combat the basic threat of inadequate world food supply.

Like the first settler in newly opened territory, the enlightened food policy leader knows where he wants to go and why it is important to get there. He knows there is more than one way to realize his destination and he knows there are difficulties. But in territory so unmapped, how does the policy leader go about charting the way to a national program? For the policy leader, unlike the early settler, advice comes freely from many quarters. Nary a nutrition conference passes without a catalog of directions drafted for his eye. But how do these mesh with reality? What are the relative economics of the various approaches? How does the policy-maker systematically weigh the many alternate means of achieving

A second article by Mr. Berg appears on p. 3.
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the predetermined targets? How, in short, does he design an operational plan to reach effectively the largest number of people for the smallest investment of resources in the shortest period of time?

These are the questions examined in recent months by the Government of India. The result is a Comprehensive Nutrition Plan, incorporating a minimum cost model which, to our knowledge, is the first of its kind ever constructed in the field of nutrition.

Basically, the model seeks to estimate particular Indian deficiencies for the year 1970-71 and to compare a number of possible avenues to determine the most economical way to overcome these deficiencies. Estimates of deficiencies are based on projected availability of each category of food produced in 1970-71, less estimated waste. These estimates are categorized by age and income group. The nutrient contents of these foods have been calculated, so that a daily per capita intake of each nutrient could be estimated for each age and income group. Finally, the intake figures were subtracted from the official minimum daily requirements for each nutrient set by the Indian Council of Medical Research. Estimates were made only of deficiencies of protein, vitamin A and iron—those nutrients considered most critical by Indian nutritionists. A distinction was made between "animal grade" protein and total protein because of the general difference in nutritive value.

For purposes of the model, the population was divided into four income groupings, by and large homogeneous groups of households with similar food consumption patterns. The critical 1-6 age group in the lowest income category was designated as a target group; this income category embraces more than 70 percent of the Indian population.

A computer exercise carried out by the Indian Institute of Public Opinion determined the 1970-71 deficiencies for the low income, 1-6 age group as follows:

	Total Protein	"Animal Grade" Protein	Vitamin A	Iron
Deficiency per person per day	21.9 gms	2.8 gms	3,068.6 I.U.	12.5 mg.
Deficiency per total group per year	608,524 tons	75,025 tons	79,681 billion I.U.	322 tons
Intake as a % of recommended allowances	57.4%	45.1%	12.4%	37.5%

Given these deficiencies, the next step was to determine a minimum cost solution for the target group, one that could be implemented under Indian conditions. This was no easy matter. Unlike most health problems, there is no professional consensus on how best to attack malnutrition. There are, in fact, more than a dozen starting points, each with its own band of advocates. The aim of this linear programing exercise was to measure pros and cons of each of these possibilities, taking into consideration economics, cultural factors, and realistic administrative constraints.

The costs compared were for the most part alternatives of production and processing rather than distribution. For example, the exercise did not compute the costs of subsidies or other government devices which might be used to assure that the bulk of a given product would be consumed by those in greatest need. The findings do, however, provide a basis upon which both public and private investment decision-making vis-a-vis these alternatives can begin.

Here are some of the findings:

1. It is invariably more costly and in many (but not all) respects harder to combat deficiencies by relying solely upon stepped up food production. In the case of protein, it would take enormous increases in food production to close the gap solely by catering to conventional eating habits. It is possible that it time—with continued increases in foodgrain yields and perhaps with some form of subsidy—adequate amounts of protein will be available from cereals to meet the requirements of the target group. The quality of this protein, however, will not be adequate unless, for example, the quality is enhanced by the fortification of the cereals with amino acids. In the case of vitamin A, a 297 percent increase in vegetable production or a 217 percent increase in fruit production would be required to meet the target group's deficiencies through "conventional" foods.

2. The single most inexpensive means of meeting the protein deficiency of the target group is with edible-grade flour from oil-seeds such as groundnut, cottonseed, and soy. This flour can be used in low-cost high-protein foods (such as Bal Ahar).

3. The least expensive means of meeting the group's animal grade protein deficiency is with fish protein concentrate—although only the non-vegetarian portion of the population could benefit.

4. When reasonable administrative, social, and logistical constraints are taken into account, it is clear that there can be no single solution to the protein problem. The least cost solution calls for differing amounts—an optimum mix—of each of the foods described above.

5. The best solution to deficiencies in vitamin A and iron is to fortify commonly consumed foods with these nutrients in their synthetic form. Imaginative new ways are being sought to introduce fortifying nutrients into the common diet. Work is currently under way in India, for example, on the fortification of salt and tea.

The Plan, presented by India's Minister of State for Health and Family Planning to the National Nutrition Advisory Committee earlier this year, sets forth a three year program based on these results. While it is premature to measure the effect this Plan may have on future programs, it is clear that the model has focused attention of those concerned on the problem as a whole. It has provided a basis for follow-up computer runs that would include such alternatives for the future as the development of new cereal strains with higher protein content and quality, of low-cost consumer protein foods in the commercial sector, and of single cell protein from petroleum and other sources. All of these now vary too greatly in price to have been included in this exercise. Perhaps as important as the short-term effects of the Indian Government's Plan is the model it represents—a model which may be helpful to other developing nations trying to come to grips with the same problem.

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THE WORLD FOOD PROBLEM: TRADE AND DEVELOPMENT

Food and Agriculture Organization
of the United Nations, Rome (FAO)

[Food production falls short of estimated average calorie needs in two-thirds of the developing countries, and of protein requirements in about half. Even with increased domestic food production, as projected to 1975, demand will not be met by then without further increases in food imports.]

There is considerable controversy on the exact magnitude of the world food problem, especially the number of people who are suffering from hunger and malnutrition. This is inevitable in view of the unreliability of the statistics of food production and consumption in developing countries, where so much of total production is for the subsistence of the producer and his family and never enters the market. But while there is controversy about exactly how many millions are affected, there is universal agreement that the numbers are immense and constitute a large part of mankind.

Nutritional requirements have been intensively studied in recent years, and internationally recommended allowances have been established jointly by FAO and the World Health Organization (WHO) for calories and proteins, as well as for calcium and certain vitamins. There are, however, a number of complications in calculating requirements, especially for protein. The available food supplies are not distributed according to requirements among the different population groups or even within families, so that in a population whose average requirements are met, some will receive more and some less than their needs. Supplies also frequently vary during the course of the year. The requirements of an individual whose body weight and activity reflect under-

nutrition and malnutrition from birth will differ from those of one whose full physical potential has been realized. The nutritional quality of the protein from different dietary sources varies markedly, so that calculations based on the national average diet may differ from those based on the actual diets consumed by particular population groups. A deficiency of calories may accentuate a deficiency of protein, since part of the protein intake must be burned up to provide energy and is thus not available as protein for tissue building and repair.

Table 1 compares average per caput calorie and protein intakes for 44 developing countries for which FAO food balance sheets are available. It also gives calculated nutritional requirements based on the latest data available for each of these countries. These broad averages can only be taken as a rough indication and they generally may be expected to underestimate the extent of hunger and malnutrition. In particular, they conceal the maldistribution of the available supplies within the population. Even on the basis of these figures, however, it appears that average calorie intakes are below calculated requirements in almost two-thirds and average protein intakes in about half of these developing countries.

TABLE 1.– CALORIE AND PROTEIN SUPPLIES COMPARED WITH REQUIREMENTS IN DEVELOPING COUNTRIES

Country	Period	Calories		Proteins	
		Supplies	Requirements	Supplies	Requirements[1]
		Calories per caput per day		*Grams per caput per day*	
LATIN AMERICA					
Argentina	1963–65	3 130	2 650	88	70
Bolivia	1961–63	1 830	2 400	49	61
Brazil	1963–65	2 780	2 350	66	63
Chile	1963–65	2 660	2 490	83	67
Colombia	1963–65	2 220	2 325	54	62
Costa Rica	1960–62	2 430	2 240	54	50
Dominican Republic	1964	2 230	2 240	53	57
Ecuador	1961–63	1 850	2 320	44	57
El Salvador	1960–62	2 030	2 230	58	59
Guatemala	1960–62	2 080	2 320	55	62
Honduras	1960–62	2 080	2 145	54	55
Jamaica	1958	2 240	2 180	58	58
Mexico	1963–65	2 670	2 360	75	61
Nicaragua	1960–62	2 420	2 255	62	62
Panama	1963–65	2 340	2 280	61	55
Paraguay	1960–62	2 520	2 320	63	62
Peru	1963–65	2 160	2 370	56	58
Surinam	1963–65	2 090	2 310	47	60
Uruguay	1960–62	3 220	2 630	104	74
Venezuela	1960–62	2 300	2 355	59	62
FAR EAST					
Ceylon	1963–65	2 080	2 190	45	52
China (Taiwan)	1963–65	2 340	2 230	60	55
India	1963–65	1 960	2 220	49	52
Indonesia	1961–63	1 980	2 160	38	52
Pakistan	1963–65	2 260	2 275	51	49
Philippines	1963–65	2 020	2 145	49	51
NEAR EAST					
Afghanistan	1963–65	1 950	2 370	58	66
Iran	1963–65	1 840	2 370	49	67
Iraq	1960–62	2 100	2 245	46	58
Jordan	1963–65	2 500	2 380	63	67
Lebanon	1963–65	2 630	2 425	78	63
Libya	1963–65	1 920	2 340	51	66
Sudan	1964–65	2 030	2 180	65	62
Syria	1963–65	2 330	2 390	69	67
Turkey	1960–61	3 110	2 550	98	75
United Arab Republic	1962–64	2 920	2 330	84	67
AFRICA					
Ethiopia	1961–63	2 040	2 245	69	58
Ghana	1961–63	2 160	2 230	49	58
Kenya	1961–63	2 120	2 280	64	65
Madagascar	1961–63	2 330	2 220	52	56
Mauritius	1963–65	2 350	...	50	...
Somalia	1961–63	1 780	2 170	52	57
Tanzania: Tanganyika	1961–63	2 080	2 340	58	63
Uganda	1961–63	2 070	2 330	50	61

SOURCE: Food balance sheets.
[1] Provisional requirements.

Trends in Food Production in Relation to Demand

Where food balance sheets are available for a number of years, they generally indicate a slow improvement in the food situation in the developing countries. However, these improvements have frequently been far from sufficient to meet nutritional requirements.

TABLE 2.- AVERAGE ANNUAL CHANGE IN FOOD PRODUCTION, POPULATION, PER CAPUT INCOME, AND TOTAL DEMAND FOR FOOD IN INDIVIDUAL DEVELOPING COUNTRIES, 1952-56 TO 1963-65

Country	Food production	Population	Per caput income [1]	Estimated total demand for food [2]
	Average annual percentage change [3]			
FOOD PRODUCTION INCREASED				
4.0 percent or more				
Libya	6.9	3.5	...	...
Korea (Rep. of)	6.2	2.6	3.3	4.2
Mexico	5.6	3.4	2.9	4.4
Venezuela	5.3	3.6	2.2	4.5
Malaysia: West	4.7	3.1	...	...
Brazil	4.6	3.0	2.3	3.7
China (Taiwan)	4.4	3.4	3.7	5.1
Thailand	4.2	3.0	2.8	4.2
3.0 to 3.9 percent				
Cyprus	3.8	1.2	2.0	1.7
Panama	3.7	2.9	3.4	4.0
United Arab Republic	3.7	2.5	3.7	4.4
Honduras	3.4	3.1	0.7	3.4
Ceylon	3.4	2.5	0.2	2.6
Ethiopia	3.3	1.7	...	...
Guatemala	3.2	3.1	2.2	4.0
Iran	3.2	2.4	...	...
Philippines	3.1	3.2	1.6	4.2
Turkey	3.1	2.9	1.4	3.7
Burma	3.1	1.9	2.4	3.1
Tunisia	3.0	1.8	2.3	3.1
2.0 to 2.9 percent				
Colombia	2.8	3.2	1.3	3.7
Syria	2.8	3.1	0.5	3.3
Pakistan	2.8	2.4	1.5	3.5
Peru	2.7	2.7	2.7	4.0
Morocco	2.4	2.8	— 0.9	2.3
India	2.4	2.2	1.4	3.2
Chile	2.3	2.4	1.3	3.0
0 to 1.9 percent				
Iraq	1.6	3.0	4.9	5.8
Argentina	1.6	1.7	1.4	1.9
Indonesia	1.3	2.2	...	...
Cuba	0.7	2.1	...	...
FOOD PRODUCTION DECLINED				
Uruguay	— 0.1	1.5	...	...
Algeria	— 0.9	1.8	1.6	2.5

[1] Per caput real product. [From OECD. *National accounts of less developed countries.* Research Division, Development Center, Paris, February 1967 (preliminary), p. 9-12] – [2] Calculated on basis of demand elasticities used in FAO *Agricultural commodities – projections for 1975 and 1985.* Rome, 1967, Vol. 2, p. 29-33. – [3] Compound rate; minus sign denotes decrease.

In most of the individual developing countries food production has been increasing faster than population in recent years, as is indicated by the data in Table 2 for the 33 such countries for which production index numbers are calculated by FAO. In 11 of these countries (or a third of those for which there are data), however, food production failed to keep pace with population growth in the period 1952-56 to 1963-65.

The growth of population, which ranges up to 3.6 percent per year in the countries shown in Table 2, is still the main component of the increase in the demand for food in the developing countries. In most of these countries, however, in spite of the disappointingly slow pace of their economic development in recent years, there has also been some increase in per caput incomes. The last column of Table 2 shows estimates of the increase in total demand for food that may be expected to have resulted from both population and income growth in those countries for which data are available for real product and for the income elasticity of demand.

This rough calculation indicates that food production has kept pace with demand in only 10 of the 25 countries for which these data are available.

Lagging food production in the developing countries has had many adverse effects on their general economic development, but it has not usually led to a decline in per caput food consumption, which appears generally to have been maintained by means of larger imports or smaller exports of food. The increase in food imports has been the most striking effect of lagging domestic food production in the developing countries. Since 1948-52, from being net exporters of food before the second world war, both the Far East and Near East have had steadily rising net imports, while the next exports of Africa have tended to decline.

Food aid from the large stocks of cereals that accumulated, mainly in North America, during the 1950s, has cushioned the foreign exchange resources of the developing countries against the full effect of the rise in food imports. In 1964-65, shipments on special terms accounted for more than half of the net cereal imports of the net importer developing countries.

In spite of food aid, however, commercial imports of food have also increased rapidly. Even shipments on special terms usually involve some foreign exchange expenditure by the recipient country. Thus, rising food imports have constituted a growing drain on the scarce foreign exchange resources of the developing countries. In some cases, lagging domestic food production in relation to demand has also caused exports of some food products to decline or to increase only slowly (e.g., exports of groundnuts from India and of rice from Burma).

Because of their shortage of foreign exchange, many developing countries have been unable to import enough to meet all of the gap between their own food production and demand. Consumer food prices have therefore risen. The extent to which the rise in food prices is merely part of the general inflation of prices is difficult to assess, but it is significant that in about half of the developing countries for which data are available, the increase in food prices has been greater than that in the overall cost of living in recent years.

Future Prospects

A number of analyses have been made in recent years which give some idea of the nature and scale of the food problem which may have to be faced in the future. The detailed results of these analyses differ as a result of the different assumptions used in them, but there is no conflict in their broad findings.

The following account is based on the FAO commodity projections, which cover demand and production for food and non-food commodities to 1975 and demand for food to 1985 as well. In projecting the demand for food to 1975, the study used two assumptions for the growth of the gross domestic product (GDP), a low and a high, in conjunction with the United Nations medium projections of population. Low and high projections of production were also made, each associated with the corresponding growth assumption for GDP. As a rule, the low production projection was based on the extrapolation of past trends, modified to take into account special conditions which might have prevailed in the past. The high production projection presupposed an acceleration of economic growth and important changes in policies.

TABLE 3.- PAST AND PROJECTED ANNUAL GROWTH RATES OF POPULATION, GROSS DOMESTIC PRODUCT, FOOD DEMAND AND PRODUCTION

Region	Population		Gross domestic product			Food demand		Food production		
				1965-75		1962-75			1965-75	
	1950-62	1965-75[1]	1958-63	Low assumption	High assumption	Low assumption	High assumption	1958-63[2]	Low assumption	High assumption
	Percentage per year									
Latin America	2.6	2.8	4.7	3.8	5.8	3.2	3.5	2.5	3.0	3.6
Far East	2.1	2.5	4.0	3.4	5.1	3.2	3.9	3.0	2.8	3.5
Near East	2.3	2.7	4.9	4.1	5.9	3.4	4.0	2.5	2.3	3.6
Africa	2.4	2.6	3.8	3.2	5.2	2.9	3.4	2.9	2.8	3.5
Total developing countries	2.3	2.6	4.3	3.6	5.5	3.2	3.7	2.9	2.8	3.6
Total developed countries	1.3	1.1	4.7	3.5	4.8	1.7	1.9	2.7	2.0	2.1
Total centrally planned countries	2.0	1.8	5.9	4.5	6.0	2.5	2.8	..	2.4	2.8
WORLD	2.0	2.0	4.9	3.7	5.1	2.3	2.7	2.6	2.3	2.7

SOURCE: FAO. *Agricultural commodities - projections for 1975 and 1985*, Rome, 1967, Vol. 1, p. 7, 9, 48.
[1] United Nations medium assumption. - [2] Computed from the three-year average of the beginning and the end of the period shown.

The assumed annual growth rates of population and GDP, and the projected rates of growth of food demand and production are shown in Table 3. Under the low GDP assumption, food production in developing countries is projected to grow by about 2.8 percent annually during the period 1962-75, or at roughly the same rate as in 1958-63. This compares with a projected increase in demand of 3.2 percent a year during the same period. According to the high assumption, the increase in food production might be raised to 3.6 percent per year, in comparison with an increase in demand of 3.7 percent a year. This would entail a significant increase in current and capital expenditures on agriculture. It would bring a considerable increase in per caput production but would not eliminate the disparity between the increase in production and demand, although this would be much smaller than under the low-income assumption. Moreover, even if the increase in production and demand is roughly in balance in Latin

America and Africa under the high assumption, the increase in food production in the Near East and the heavily populated Far East would continue to lag behind demand.

Under both assumptions, the gap between production and demand in developing importing countries would increase. The cereals gap of these countries would total about 30 million tons in 1975 on the high-income assumption, and about 50 million tons on the low assumption, as compared with actual imports averaging 23 million tons a year in 1961-63. The total cost of the specified foods which would have to be imported by these countries if projected demand under either income assumption were to be satisfied would total more than $8,000 million (at 1961-63 prices), as compared with actual imports of about $3,000 million in 1961-63. The composition of the imports would differ under the two income assumptions. Cereals would remain the major food deficit in both cases, but their relative importance would decline if the higher level of income were achieved. Imports of livestock products and of fats and oils would increase sharply under the high-income assumption if projected effective demand were fully met.

The projected levels of demand in 1975 would result, provided supplies were available, in an increase in per caput calorie intakes over the 1962 level of only 6 percent under the low assumption, and 11 percent under the high assumption. Taking into account the unequal distribution of food supplies among the populations of developing countries, large numbers of people would remain undernourished in 1975. Under the assumptions made, the problem of undernutrition could not be effectively solved until 1985, and then only if the high-income assumption should be realized. If the growth of GDP was much less than 5.5 to 6 percent a year, effective demand would not result in an adequate calorie level until well after 1985. For protein consumption, the study does not envisage any basic improvement even by 1985, since any increase in the share of animal protein in total consumption is likely to be offset by a smaller share of vegetable protein.

The projections indicate that the developed countries and some developing countries have the potential or reserve capacity to produce sufficient quantities of food to meet the projected deficits of the developing countries in 1975, at least for cereals. The prospective balance of payments situation of the developing countries suggests, however, that most of the importers will not be in a position to finance the necessary imports entirely on commercial terms.

[Excerpted from the Monthly Bulletin of Agricultural Economics and Statistics. Rome: FAO, Vol. 17, No. 5, May 1968, pp. 4-10.]

TWO VIEWS ON HEALTH AND THE POPULATION PROBLEM

[Because of the important impact of nutrition on health and mortality, and because the problem of adequate nutrition is also a population problem, these two divergent views are presented. The first emphasizes the eventual contribution of better health to population control; the second stresses an opposite short-run influence.]

FIRST..... President's Science Advisory Committee, Report of the Panel on the World Food Supply, Ivan L. Bennett, Jr., Chairman.

Population Growth and Food Needs

If the world population continues to increase at 1965 rates, 52 percent more calories will be required in 1985. This estimate is based on calories actually consumed and does not consider production, losses, quality, and wastage of food. If, as a result of family planning programs during 1965-85, one optimistically assumes a progressive decrease of 30 percent in the probability that a woman of given age will bear a child (fertility rate), the caloric requirements will still be 43 percent higher by 1985.

These projections of world food requirements, however, fail to depict the plight of the developing countries. India, at her present population growth rate, will require 108 percent more calories by 1985; with a 30 percent reduction in fertility, the increased nutritional requirement will be 88 percent. The corresponding figures for Pakistan's increased caloric needs in 1985, allowing for the same reduction in fertility, are 146 percent and 118 percent, and for Brazil, 104 percent and 91 percent.

The Panel is unanimous in supporting and urging, in the strongest terms, continuing and increasing emphasis upon research, technical assistance, and capital funding in family planning. Only by such continuing

emphasis and effort can the outpacing of food production by population growth be avoided as a problem that might continue well into the next century. The long lag-period that necessarily precedes the main effect of programs of family planning adds to the urgency of the need for action now.

Nutrition, Infant Mortality, and Family Planning

There is, however, another more complex, less well-known, and crucially important relationship between nutritional needs and family planning. Surveys of the attitudes of married couples in developing countries show that the numbers of children desired are higher than in the developed nations. Furthermore, the average number of live births per woman in the developing countries is 30 percent greater than the desired number of children.

Emphasis on the desire for heirs leads to large families. Only one son may be needed for ritual or economic purposes but it is common to want two sons to ensure against the death or incapacity of one. Couples must average four children to obtain two sons.

Availability and efficacy of pills, intra-uterine devices and other technical means for birth control are largely irrelevant until couples have secured the desired number of living children.

If we assume the necessary preconditions for reducing fertility rates in the developing countries are low infant and child mortality and a public awareness that mortality is low, then we have the apparent paradox that a reduction in childhood mortality will reduce rather than raise the rate of population growth.

[Excerpted from The World Food Problem: Report of the Panel on the World Food Supply. Washington (D. C.): U. S. Government Printing Office, May 1967, Vol. I, pp. 12 and 14.]

SECOND. . . . . Kingsley Davis, Professor of Sociology and Director of International Population and Urban Research, University of California, Berkeley.

Rising Birth Rates in Underdeveloped Countries

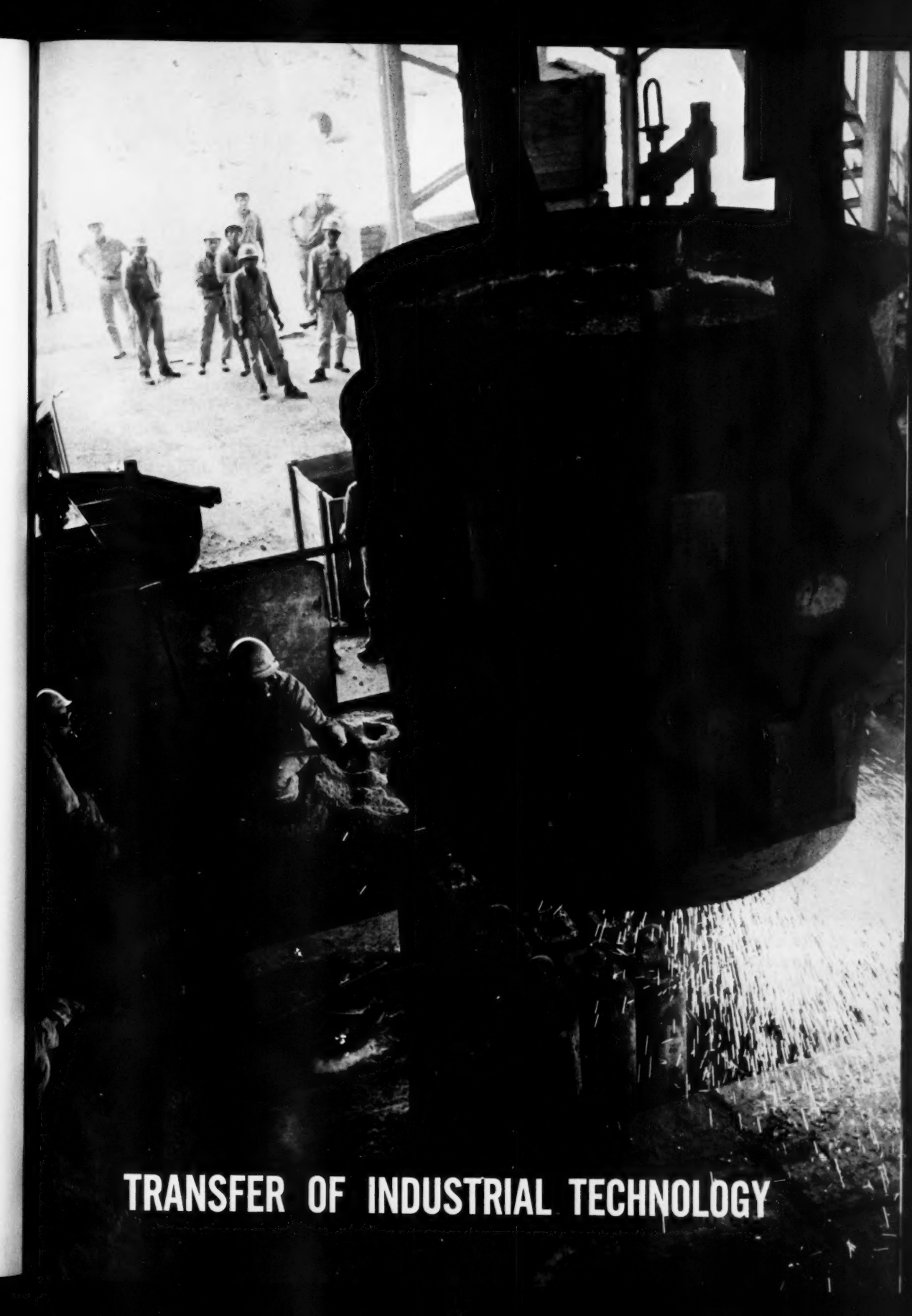
In ten Latin American countries, between 1940 and 1959, the average birth rates (age-standardized), as estimated by our research office at the University of California, rose as follows: 1940-44, 43.4

annual births per 1,000 population; 1945-49, 44.6; 1950-54, 46.4; 1955-59, 47.7.

In another study made in our office, the recent trend was found to be upward in 27 underdeveloped countries, downward in six, and unchanged in one. Some of the rises have been substantial, and most have occurred where the birth rate was already extremely high.

The general rise in fertility in backward regions is evidently not due to failure of population-control efforts, because most of the countries either have no such effort or have programs too new to show much effect. The rise is due to the very circumstances that brought on the population crisis in the first place—to improved health and lowered mortality. Better health increases the probability that a woman will conceive and retain the fetus to term; lowered mortality raises the proportion of babies who survive to the age of reproduction and reduces the probability of widowhood during that age. The significance of the general rise in fertility, in the context of this discussion, is that it is giving would-be population planners a harder task than many of them realize. Some of the upward pressure on birth rates is independent of what couples do about family planning, for it arises from the fact that, with lowered mortality, there are simply more couples.

[Excerpted from "Population Policy: Will Current Programs Succeed?," Science, Vol. 158, No. 3802, 10 November 1967, p. 734. © 1967 by the American Association for the Advancement of Science, Washington, D. C.]


TRANSFER OF INDUSTRIAL TECHNOLOGY

CASTING STEEL INGOTS AT THE MALAYAWATA STEEL PLANT
AT PRAI, MALAYSIA.
(PHOTO: INTERNATIONAL FINANCE CORPORATION)

INTERMEDIATE TECHNOLOGIES

Julia Porter and Alfred Latham-Koenig

[Industrialization with capital-intensive equipment has spread its benefits in a narrow circle, displacing artisans and doing little for agriculture. "Intermediate technologies" would spread employment and productivity increases more widely and develop local entrepreneurship.]

Each new stage of the development of Western societies has been ushered in by technological transformations—but these transformations took place in response to certain stimuli, certain needs within the societies themselves; the changes were evolutionary and related to the level of technical sophistication and organization reached by these societies.

In the developing countries, on the other hand, the West has tried to short-circuit this process and to introduce the most advanced technologies to societies which were, for the most part, still in a pretechnological age. The result has often been social disruption, the aggravation of unemployment and little change in the standard of living of the majority. We are now beginning to realize that development is an organic growth and that to intermediate levels of development there must correspond intermediate levels of technologies.

Within the last ten years the main disadvantages of the emphasis on rapid industrialization as the panacea for developing countries have become more and more apparent. They can be summarized as follows:

Mrs. Porter and Mr. Latham-Koenig are Directors of the Intermediate Technology Development Group, London. Mr. Latham-Koenig is Economic Adviser to McKinsey & Co., Inc., Management Consultants.

Little benefit accrues to the agricultural sector of the economy.

Industrial development tends to gravitate to the more densely populated parts of a country and spreads its benefits in a narrow circle, occasionally wreaking, by job destruction, havoc in a far wider area.

Capital-intensive industries require minimum numbers of highly trained personnel and there is a limit to the speed at which such people can be trained.

The development of such industries requires extensive imports of plant and machinery and will thereby either place a severe strain on a country's balance of payments or depend heavily on "grant aid."

A good example is the Indian glass industry. The introduction of automatic machines in the last decade to replace hand-operated machines has been a total failure. The new glass industry is becoming critically dependent on foreign exchange, has not created significant employment, and has tended to cripple local initiative.

In spite of a greatly increased volume of aid per capita, most developing countries are still as incapable of feeding themselves now as they were before this massive injection of aid took place. Even the annual rate of increase of industrial production has dropped in the last five years and is likely to decline even further unless agricultural production can be raised. Worse still, unemployment and underemployment, especially in the 18-30 age group, has now increased to alarming proportions in the rural areas.

Faced with this disappointing performance, planners in developed and developing countries alike have begun to reappraise the conventional strategy of development; they have been forced to the conclusion that a sophisticated technology, which is essentially alien to the environment in which it is supposed to work, cannot possibly take root there. The reason is simply that vital cooperating factors, the infrastructures which enable the advanced machinery to operate smoothly and profitably in the West, are usually not found in developing countries; in particular, the human elements—the technicians, accountants, managers—are conspicuously absent.

The modern plant in this new environment can in fact be likened to one of those medieval knights who, without a trained retinue of serfs to help him into his heavy armor and upon horseback, was quite useless on the battlefield. Planners are therefore beginning to recognize that the right technology for developing countries is the one which matches the available human resources, the social structure, and the size of the market.

Dr. Schumacher, one of the most persuasive advocates of intermediate technology in the West, has suggested the following approach:

> Workplaces should be set up in places where the people are actually living.
>
> These workplaces should be cheap enough to be created in large numbers without demanding either a high level of domestic saving, or requiring imports costly in foreign exchange. Investment per workplace should be related to income per head.
>
> Production methods should be simple, so that the demand for high skills is minimized.
>
> Lastly, production should be based on local materials and for local use. This has a multiplier effect and output, income, and employment are stimulated in related industries and trades.

Specific advantages of this method are that it taps local savings outside capital markets, not readily available for productive investment, and local resources of entrepreneurship and management—the scarcest factors of production in developing economies. By providing the manual workers of developing countries with improved, simple and sturdy tools, intermediate technology can raise their productivity appreciably.

This is, in fact, one of the most powerful arguments in favor of intermediate technology; it enables the masses, and not just a privileged few, to help themselves and to participate in the process of development. It is too easily forgotten that the men thrown out of work in developing countries by highly productive machines cannot, as in industrialized countries, be readily absorbed into other sectors of the economy. They, therefore, swell the mass of the unemployed, with a consequent loss in the national income of the country and an increase in human misery.

A slow but steady growth of productivity which spreads right through the economy is infinitely better than a spectacular rise in productivity in a few isolated areas which remains confined to these areas and creates unemployment all around.

[Excerpted from Manas. Los Angeles: Manas Publishing Company, Vol. XX, No. 49, 6 December 1967, pp. 1-2 and 7-8.]

VITA AND ITDG

[Two organizations in the West have concerned themselves with technology for developing countries. The United States-based VITA (VITA, Inc., College Campus, Schenectady, New York, 12308) concentrates on solving rural technological problems. The British ITDG (9 King Street, Covent Garden, London W. C. 2) disseminates information on low-cost equipment and technology.]

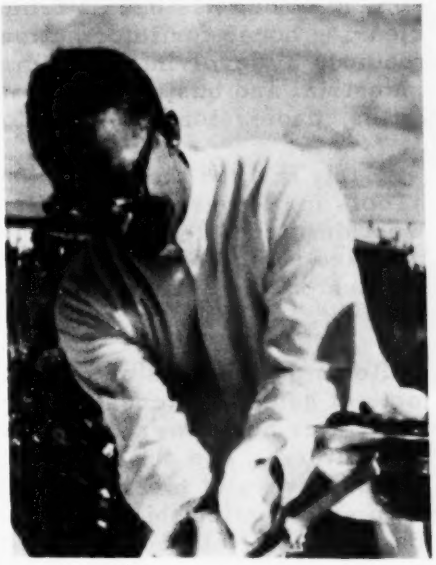
VOLUNTEERS FOR INTERNATIONAL TECHNICAL ASSISTANCE, by Hallowell Bowser, General Editor of the Saturday Review, New York.

Since its founding in 1960, the Volunteers for International Technical Assistance (VITA) have had an inpouring of queries from villages in Asia, Africa, and Latin America. The questions are geared to the everyday problems of rural-village life: Can you design for us a simple hand-run washington machine? How can we harvest jute growing six feet under water? We have very little scrub wood or other fuel to burn—can you tell us how to build a stove that cooks by solar power?

Such puzzlers are familiar to VITA's seven-man professional staff, whose headquarters is a small office on the campus of Union College in Schenectady, New York. The first step in dealing with a question is to check it out against the office data bank, which has grown since VITA merged in 1967 with DATA, a group which had done similar work in California. The combined files now contain answers to more than 12, 000 questions.

If the data bank nonetheless comes up dry, the staff thumbs through its file of 6, 000 American scientists, technicians, and other specialists who act as volunteer advisers, and sends the question off to three of them. Answers, often complete with detailed sketches, usually come back in a few days and are

then sent to villagers overseas. Sometimes the three advisers queried come up with three quite different, quite workable suggestions.



The volunteers have, incidentally, answered the three sample questions cited above, and they are now part of the data bank. In the case of the request for a sun-oven, one VITA adviser designed a $3 solar cooker, such as the one pictured here in use in Tanzania (Photo: VITA, Inc.), that brings a quart of water to a boil in fifteen minutes. VITA's other design coups include the development of an inexpensive wood-turning lathe and a high-speed jigsaw, both of them operating off power rigs made of old bicycle parts.

The Agency for International Development has reprinted and widely distributed Village Technology Handbooks containing typical VITA solutions to community-level problems in the industrially emerging nations. Recently VITA created a Village Technology Center (VTC) to build and test equipment, and to demonstrate its use for training and other purposes. A VTC Catalog, "Tools for Development," lists the items tested in and available from the Center (both the Handbook and Catalog can be obtained from VITA). The Peace Corps regularly sends volunteers to VITA's VTC to study working models of VITA designs before they ship out on overseas assignments.

[Excerpted from "New Uses for Old Bicycles," Saturday Review, 21 September 1968, p. 26. © 1968 by Saturday Review, Inc., New York. Reprinted with Permission. This article or parts thereof may not be reproduced in any form without permission from the publisher.]

INTERMEDIATE TECHNOLOGY DEVELOPMENT GROUP, by George McRobie, Chief Executive of ITDG, London.

Since its foundation in 1966, the Intermediate Technology Development Group has been attempting to build up, in various ways, a clearing house for information on low-cost tools, equipment, and methods by involving the administrators concerned with aid, the industrial and business community, and the communicators—universities, professional associations, the intellectual fraternity.

Early in 1968 the ITDG published a 200 page illustrated directory, "Tools for Progress," the first directory every published in the West devoted solely to low-cost tools and equipment. The first edition was restricted to items manufactured in the United Kingdom; discussions are proceeding about the possibility of a European edition.

Recently a series of specialist panels have been set up on subjects of general interest to developing countries—on low-cost building, water and power, rural health, food technology, cooperatives, agriculture. The aim of each panel is to assemble data on efficient, low-cost ways of meeting these needs and to discover effective ways of communicating this information to developing countries. Some of the panels are already associating themselves with projects overseas.

The ITDG is also encouraging the formation of groups similar to itself in developing countries—groups are active in India (The Appropriate Technology Development Group), Ghana (Kumasi Technology Group), Kenya and the Caribbean and one is likely to be formed in Pakistan soon. These, we hope, may develop into documentation centers on low-cost technologies in their respective countries.

We are currently working on the setting up of an information clearing system in the United Kingdom and on building up a consultancy service on low-cost technologies. The ITDG, which has the legal status of a charitable trust and a non-profit limited company, depends entirely on private sources of finance: membership subscriptions, and donations.

[Excerpted from a statement prepared for the International Conference on The Interdisciplinary Aspects of the Application of Engineering Technology to the Industrialization of Developing Countries, School of Engineering, University of Pittsburgh, Pennsylvania, 20-25 October, 1968, p. 5.]

PROGRESSIVE INDUSTRIAL TECHNOLOGY FOR DEVELOPING COUNTRIES

International Labor Office, Geneva (ILO)

[Technological choices should be based on comparative costs, provided that interest and wages reflect the real costs accurately. Correct decisions, which make capital funds of developing countries go farther and hasten their growth, can include completely new or modern designs, old designs, or second-hand equipment in varying circumstances.]

The Choice of Industrial Technology

There has been much controversy over the relative merits of "capital-intensive" and "labor-intensive" technology in developing countries. On the one hand, it may be felt:

1. That the building up of an industrial sector employing the most modern and advanced technology is the hallmark of an economically developed country, and of a country determined to take its place as rapidly as possible among the developed countries.

2. That it is necessary to invest with the future in mind, and that machines and equipment not of the latest design will rapidly become obsolete.

3. That advanced technology exposes all who come in contact with it to the forces of change and development, thus exerting a pervasive influence on the ways of life throughout the society and, in particular, enabling managements and workers to acquire the technical skill and knowledge that are indispensable to a modern economy.

4. That industries with the greatest growth potential are those employing advanced technology.

5. That a high degree of capital intensity permits large profits to be made and a large proportion of these profits to be ploughed back to promote faster growth.

On the other hand, it may be felt:

1. That advanced industrial technology has developed in response to the needs of industrially advanced countries with large markets, a relative abundance of capital and entrepreneurial and managerial skills, and a shortage of labor.

2. That transplanting industrial technology to countries where it will operate under conditions for which it was not designed can be an expensive mistake.

3. That countries should not seek to make a sudden, sharp break with their past, but should build on the existing foundations, thus developing and adapting traditional skills, knowledge, and techniques.

4. That where capital is scarce, capital-intensive technology means concentrating it in a few large plants while keeping the rest of the economy starved of capital, and that this accentuates the dualism characteristic of developing economies and societies, sharpening the contrast in living standards, opportunities, and outlook between the modern and the traditional sectors and limiting the number which can be absorbed into the modern sector and exposed to its modernizing influences.

5. That if capital-intensive technology does enable a few large, modern plants to make big profits, this does not mean that the total profits, both public and private, for the economy as a whole are necessarily greater. Nor is it necessarily the case that more resources will be invested than if capital had been spread widely.

It is sometimes thought that anyone who advocates the selection of labor-intensive products and methods in developing countries is trying to "fob them off" with something inferior. Indeed, it is quite likely that industrial processes in the future will come to be carried out increasingly by machines rather than by men. When one considers the comparative advantages of men and machines, most of the advantages in industrial processes seem to lie with machines. Where fabrication is concerned, men can shape and combine materials with simple hand tools by such actions as cutting, striking, twisting, rubbing, and stirring. However, men cannot attain great speed or great precision, and they can work only within certain temperature ranges and in the absence of poisonous fumes. Machines

can perform all of these jobs and more; they can also do the work with greater speed and precision, under various conditions. With respect to transport, men can move limited weights rather slowly for rather short distances; machines can move heavy weights speedily for long distances. As far as control is concerned, men can look, listen, feel, smell, and taste; their speed and accuracy, however, is limited. Men still have an advantage over machines in the field of analysis, and human beings have a monopoly in connection with personal services. In industry, types of work other than those just cited seem likely to pass increasingly into the hands of machines.

Complete automation of industry has not yet happened, even in the developed countries, and if it ever comes to pass, may take several generations. During the transition period, it is reasonable and necessary, in selecting industrial products and processes, to take account of differences between countries in factor proportions, factor prices, and size of markets.

This suggests that countries in which capital is scarce and expensive and labor cheap and abundant, would do well, in planning their industrial development, to look for ways of using more labor and less capital. This is not a matter of being content with inferior, old-fashioned ways of doing things. The least-cost combination of labor and capital in an industrial process in a developing country will often be one which provides more employment per unit of output than the least-cost combination for the corresponding process in a developed country. This is especially likely if the developing country has a comparatively small market—and, of course, the size of a market depends not so much on the size of a population as on its purchasing power. With short production runs, it is profitable even for developed countries, with a high ratio of wages to interest, to use the most labor-intensive methods.

The full strength of the case for using abundant labor where possible to save scarce capital in developing countries may, however, not be reflected in comparative cost figures alone. It is clear that money costs and prices in developing countries often do not accurately reflect real costs. In particular, capital frequently appears cheaper than it really is (finance may be made available from public sources at rates of interest lower than would have had to be paid in an open market) while labor often appears more costly than it really is. (The real cost of employing a hitherto unemployed or greatly underemployed worker, in the sense of the production foregone by withdrawing him from what he was previously doing, may be almost nil.) In addition, the cost of foreign exchange often appears less than it really is. (If countries have overvalued currencies, but do not want to devalue, foreign exchange has to be rationed and is allotted to successful applicants at a price below what they would

have been willing to pay rather than go without.) These cost distortions make it rational for private enterprise, and the managers of public enterprises, insofar as they think primarily in terms of maximizing the profits or returns of their own undertakings, to choose a product-mix and a type of technology that use more capital and foreign exchange and less labor than would be in the best interests of the country as a whole. This has led to the suggestion that governments, for planning purposes, should use not market prices but rather "shadow prices," reflecting the best estimates they can make of the real costs of different resources from the social point of view; and that governments might also wish, through appropriate fiscal measures, to give inducements to private enterprise to act as though capital and foreign exchange were dearer and labor cheaper than the prevailing market prices.

Industrial and other projects may be grouped in principle in four categories:

1. Projects in which labor-intensive, capital-saving technology, with existing methods and prices, yields money economies in production. In all such projects, there is a clear case for choosing labor-intensive technology; the selection of capital-intensive technology for non-economic reasons, such as prestige, would involve an evident misuse of resources.

2. Projects in which labor-intensive techniques, when used carelessly or in traditional fashion or without adequate supervision, involve rather higher money costs than would more capital-intensive techniques, but in which at the same time there are opportunities (through better management, work study, better design of simple tools, etc.) to adapt labor-intensive techniques in order to produce at equal or lower cost than with more capital-intensive techniques. There is a clear case for doing all that can be done at reasonable costs to change these projects into category (1) projects and then to carry them out by labor-intensive methods.

3. Even when all feasible measures to improve the efficiency of labor-intensive techniques have been taken, there are projects in which the techniques will still involve higher money costs of production than would more capital-intensive methods, but not higher real costs (i.e., they would be cheaper if shadow prices, accurately reflecting real costs, could be used instead of market prices). The simplest way of counteracting the cost distortion would probably be to raise interest rates, or at least to make sure that finance is not available on subsidized terms.

4. The difference between these and the previous category of projects is that the cost differential in favor of advanced

technology is greater than the cost distortion produced by the use of market prices instead of shadow prices. On economic grounds there is no case for using anything but capital-intensive technology in such projects.

A country that chooses to confine highly capital-intensive technology to the last category of projects may thereby save much capital, which can be used to provide more jobs and/or to raise the productivity of labor in capital-intensive projects. This could result in a more even spread of capital throughout the economy and a progressive adaptation of technology to growing markets, knowledge, skill, and availability of capital—hence, the use of the word "progressive" in the title of this paper.

Examples

Examples drawn from the experience of ILO in management development and small-scale industry can illustrate cases in which transplanting advanced industrial technology to conditions for which it was not designed seems to have given poor results.

Plastic shoe manufacture. One country imported two plastic injection moulding machines costing $100,000 with the moulds. Working three shifts, and with a total labor force of 40 workers, they produced 1.5 million pairs of plastic sandals and shoes per year. At $2 per pair, these were a better value than the leather footwear at the same price. But it is doubtful whether the country as a whole benefited. The result has been that 5,000 artisan shoemakers have lost their livelihood and the markets for the suppliers and tanners of leather, hand tools, cotton thread, tacks, glues, wax and polish, eyelets, fabric linings, laces, wooden lasts, and cardboard boxes have been reduced, since none of these is required for plastic footwear. As all the machinery and the material has to be imported, while the leather footwear was based almost wholly on indigenous materials and industries, the net result has been a decline in employment and in real income within the country.

Ceramic plant. A ceramic factory making floor and wall tiles previously imported its hand-operated presses. As a result of close cooperation with local small engineering workshops, it was able to have replacement presses made locally, using castings moulded from scrap metal in small foundries and machined on general-purpose lathes and drilling machines. The tiles themselves were made from indigenous clay deposits, and fired in kilns composed mostly of local refractory bricks. Thus, output, income, and employment were stimulated in a number of other industries and trades, e.g., scrap metal, foundry, carbon, refractory, engineering, quarrying.

This multiplier effect was just beginning to make itself felt when it was decided to build a modern large-scale ceramic plant in place of the existing one, with fully automatic presses, continuous tunnel kilns, etc. This equipment required special steels and engineering skills, refractories with a high aluminium oxide content and technical know-how, which were not available locally and had to be imported. Because of the high speed of operation, very malleable clays were required and these also had to be imported. In the end, the consumer received a poorer quality, dearer product because the breakage rate was higher. Employment and net output declined in the ceramic and allied industries and the country's trading deficit widened.

Two examples may be given of the successful use of technology in industrial projects (in one case, advanced technology) well adapted to the needs and conditions prevailing in the developing countries concerned.

Manufacture of sewing machines. An Asian country which had formerly imported sewing machines decided to promote its own sewing machine industry. A nucleus already existed in small workshops manufacturing replacement parts for imported models. Profiting from the temporary protection afforded by import restrictions, local entrepreneurial initiative quickly appeared to coordinate and expand the activities of these specialized workshops and to set up assembly units. In a few years the industry, equipped with general-purpose lathes and drills, was turning out models at 60 percent of the price of previous imports. The local sewing machines had a more limited range of operations, and were less accurate, but because of their lower price, they had opened up a new market among small-scale clothing and footwear establishments, thus increasing their efficiency. By 1966, import restrictions could be relaxed and the industry was strong enough to have established a thriving export trade to neighboring countries.

Fiberboard plant. A fiberboard plant was set up in an African country. This cost $2 million and employed only 120 workers directly, because the high pressures and great bulk involved required very heavy machinery. However, it processed the residue of sugarcane and maize stalks that would otherwise have gone to waste. Thus the value added during the process was high and it provided additional incomes to the farmers. The finished product was a good, cheap substitute for certain kinds of wood for furniture and housing. This wood had previously been imported, so foreign currency was also saved.

Sources of Appropriate Technology

The optimum choice of technology can only be made if a full range of alternatives is available. Unsuitable techniques are often applied because there is nothing else on the market except machinery which has been designed to meet other needs. The brand new, the present-day and the past are all potential sources which should be tapped.

New Designs

The most effective means of overcoming economic underdevelopment would be to apply accumulated scientific knowledge to solution of the particular problems of the developing countries. There is undoubtedly a great need for original designs which will incorporate recent inventions but will at the same time take account of the scarcity of capital and of certain managerial and operative skills in the developing world. Innovation is required so that local raw material can be substituted in certain processes for the different types which are imported at present. Varying climatic conditions may require new solutions to familiar problems.

Working parties have been formed in India and the United Kingdom to undertake this research and the United Nations Advisory Committee on Science and Technology is keenly interested in the problems of adaptation of designs and methods. Much valuable pioneer work has been done by specialist institutes such as the Tropical Products Research Institute in London. Technological research institutes are now being set up in some countries with assistance from the Special Fund component of the United Nations Development Program. The ILO technical training and development center in Turin, Italy, is expected to contribute in this field, as have the productivity centers and small industry institutes which the ILO is assisting in various places. But only the surface of the problem is being scratched. For example, techniques on which further research is needed include:

1. Capturing the heat of the sun by means of reflecting mirrors to distil fresh water from salt water, and to serve as an energy source for industrial purposes.

2. The processing of date-palm fibers to replace wool and hair in upholstery stuffing.

3. The extraction of creosote and charcoal from the husks and shells of coconuts, and of biological insecticides from coconut oil.

Modern Technologies

As emphasized previously, modern technology has a role to play. Not to use such techniques at all would be as wasteful as to use them indiscriminately. What types are likely to pass through the screening that has been proposed? Four main groups can be distinguished. The first consists of technical know-how with little or no capital element. Improved ways of making or growing things as a result of deeper understanding of the chemical, physical, and biological properties of products and materials fall into this category.

The second group consists of technology where the tool element can be easily separated from the labor element. One particular process in a series of operations may have to be performed by a particular machine if consistent quality and precision in the final product are to be maintained. The ancillary operations could be carried out by hand methods if labor were abundant and cheap.

The third category covers machines which replace non-existent human skills, or skills which would be very expensive to develop through the provision of educational facilities.

The fourth category embraces those modern technologies which may be the only effective means of exploiting a country's physical resources, which would otherwise lie idle, and which form the basis of other indigenous industries. Examples might include the use of color charts, penetrometers and triaxial compression testing machines for measuring the proportion of soil and clays, leading among others to the manufacture of improved ceramic products.

Long-Established Designs

There may still be very great scope for the use of equipment which has been superseded in industrially advanced countries because it is no longer economic under present conditions in such countries. Such equipment may, however, be employed profitably in the small industries and craft workshops which provide the bulk of consumer goods and services in developing countries. Many designs exist in industrially developed countries which are not to be found in catalogs and which may have to be dug out of the archives of patent offices and of long-established machinery manufacturers. Trade associations could carry out the work of sifting and collating such designs, with the help of United Nations or bilateral aid funds. The designs could be sent to research institutes in developing countries, which would disseminate the specifications and drawings to workshops and manufacturing firms and assist them with development.

Major international companies that are setting up subsidiaries in developing countries could contribute considerably to this effort. The Philips Electrical Group has shown the way by establishing, at Utrecht in the Netherlands, a pilot radio assembly plant for training future managers and technicians to man their overseas factories. In that plant, only simple and commonly available tools are used and the complete process is "packaged" for reproduction abroad. Some twenty countries are now producing radios using techniques developed at Utrecht.

The Intermediate Technology Development Group in the United Kingdom, formed in 1965, is currently producing an illustrated buyer's guide to British tools and equipment, entitled "Tools for Progress," which lists thirty-one categories of inexpensive equipment and tools under the main headings of agriculture; metal working and machine maintenance; power and water supply.

Concrete examples of "intermediate" processes and techniques are:

Bakery industry. Steam pipe ovens which ensure an even dispersion of heat by means of coiled steam pipes; drawplate ovens in which the loading and unloading are speeded up by putting the plate of the oven on wheels and rollers; T-arm kneaders in which a single reciprocating arm kneads the dough in a rotating mixing bowl. This equipment is more advanced and efficient than brick-lined, open-frame ovens and hand mixing, but is much less capital-intensive than turbo-radiant traveling ovens or continuous mixers.

Ceramic industry. Hand-operated jiggers for forming plates, semi-automatic presses for tiles, gravity-fed extruders for pipes. These are all superior to traditional methods but less expensive than tunnel kilns and fully automatic equipment.

Shoe industry. Simple sewing machines (first introduced in 1859) for stitching the sole to the upper and insole. This is quicker than hand stitching but may be more appropriate than vulcanizing or injection moulding equipment for soling in some countries.

Second-Hand Machinery

Second-hand machinery is often less complex than present-day machinery, so that it is easier to operate and maintain where certain skills or experience are lacking. It is usually much cheaper than new equipment. Thus, a given investment fund may go further and the output in relation to the capital input will be high. Some of

the widespread resistance to second-hand equipment stems from a fear of being saddled with worn-out, obsolete machines, as well as from a rejection of what seems to be "second-best." These inhibitions may weaken if it is realized that a large market exists in the most advanced countries for this surplus equipment. In the United States the number of second-hand metal-cutting and metal-forming machines sold exceeds that of new machines: the ratio is currently about 2:1.

An example of comparative costs when using a second-hand and a similar new sole-stitching machine is given below:

	Second-Hand Model	New Model
Purchase price	$1,000	$5,000
Depreciation period	5 years	10 years
Interest rate on loans	15 percent	15 percent
Yearly output	50,000 pairs	70,000 pairs
Number of operatives	1	1
Costs per year:		
Depreciation and interest	$275	$875
Annual wage cost	$500	$500
Fuel and power costs	$50	$50
Light and floor space and insurance	$50	$50
Repairs and maintenance	$75	$100
Total annual cost	$950	$1,575
Cost per pair	$0.0190	$0.0225

This example is based on actual costs which have been rounded off for simplicity. Thus, despite the fact that the new sole-stitching machine has a 40 percent greater productivity and double the anticipated working life of the older model, its cost per pair is 18 percent higher. The reason for this is that capital costs are high and wages low.

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SECOND-HAND EQUIPMENT FOR DEVELOPING COUNTRIES

Expert Group on Second-Hand Equipment
for Developing Countries,
S. S. Marathe, Chairman

[The quantities of second-hand equipment generated in industrialized countries are considerable and can be expected to increase in the future. No country can base its economic development on second-hand equipment; but in certain fields, and with certain safeguards, its use can make a significant contribution to the process of industrialization.]

The principal causes for the generation of second-hand equipment are:

Modernization. The process of industrialization involves a constant introduction of new production processes, and new products. Some of the available equipment, while not obsolete, will as a result of these developments be sold second-hand.

Obsolescence. Equipment becomes obsolete when replaced by other equipment which performs the same function better or at more economic rates, or both. Such equipment is usually either kept on a stand-by basis or sold as second-hand. Obsolete equipment need not be old or worn, and may, in fact, never have been used. Obsolescence is a relative term, and equipment obsolete in one set of conditions may still be technologically and economically adequate under a different set of conditions.

Closing of plants and mergers. The liquidation of plants for economic, technical, or other reasons

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accounts for a significant part of the equipment on the second-hand market. In the United States, in 1964 alone, there were 2,254 business failures in manufacturing and mining. Plants are usually sold "as is," and second-hand machinery dealers are the main buyers.

Old age and physical deterioration. Most of the equipment discarded for this reason is sold for scrap, and is only occasionally used for odd jobs. It should not be considered for possible use in developing countries.

Government surpluses. The main source of this category of second-hand equipment is the United States Government. Second-hand equipment becomes available as the result of obsolescence or completion of contracts for which government equipment was used; its physical condition ranges from new to scrap. It is listed in excess-property catalogs published by the U.S. General Services Administration and made available through the Defense Industrial Plant Equipment Center.

The second-hand machinery market in the United States is the single largest source for this category of equipment. The U.S. Agency for International Development (AID) exports excess U.S. Government equipment to developing countries, but it deals only with governments and not with private interests. Great Britain's second-hand market is the largest in Western Europe, and is about one-fifth the size of the U.S. market. Much of the British second-hand equipment is exported to the Commonwealth countries. In the Federal Republic of Germany the supply of second-hand equipment is limited because the bulk of it now in use is of late vintage. However, under its foreign aid program West Germany supports the export of second-hand equipment to developing countries by providing financing. The U.S.S.R. and East European countries redeploy their used equipment in domestic industry and have not entered the international market.

In the United States there is an established second-hand market for virtually every type of industrial equipment. The September 1965 issue of the Used Equipment Directory lists 576 used equipment dealers, and 17,000 pieces of equipment for sale in the following categories:

Air moving (fans, blowers)	Heat treating	Power
Chemical	Inspection (gauges, micrometers)	Refinery
Controls	Machine tools	Rock products (crushers)
Construction	Maintenance	Rubber
Electrical	Material handling	Steel Mill
Fabricating (shears, levellers)	Metal forming	Testing
Food	Mining	Tooling
Foundry	Plastic	Welding
	Plating	Wire
		Woodworking

Most of the commercial transactions in second-hand equipment are within the industrialized countries themselves. For instance, the United States Machinery Dealers National Association reports that export sales for its members in 1964 were $22.4 million, only 5.5 percent of the total sales figure.

Suitability of Second-Hand Equipment for Developing Countries

The most frequently cited advantages of second-hand equipment are: lower operating costs, shorter delivery periods, suitability for small-scale operation, simpler maintenance, greater ease of manufacturing parts locally, less skill needed for operation, a more flexible replacement policy.

The disadvantages of second-hand machinery most often listed are: shorter economic life, increased risk of obtaining a machine in unsound technical condition, increased risk of breakdown, higher maintenance costs, lack of spare parts, lower ability to work to fine tolerances, lower product quality and increased spoilage, greater difficulty in locating the precise equipment needed, and financing difficulties.

In our view, both these advantages and disadvantages are debatable, being valid in one set of circumstances, and invalid in another. One definite advantage of second-hand equipment on which there is general agreement is that it can be acquired at a cost considerably lower than new equipment. But there is no existing reliable method for determining, a priori, the types of second-hand equipment suitable for use in developing countries. The selection of proper equipment requires knowledge of equipment as well as the exact purpose for which it will be used. This knowledge is available from the supplier and from engineering organizations. In all cases, the supplier should be aware of the exact purpose for which the equipment will be used.

Some of the pertinent considerations are:

1. Conditions in the countries must be kept in mind; for example, equipment to be used in tropical countries may have to be specifically adapted.

2. Complete plants or a number of integrated machine units are often a better buy than single machinery units.

3. Long-lived second-hand equipment (such as most of the manufacturing and electrical equipment) can be used to better advantage than short-lived second-hand equipment (e.g., transportation equipment, with such exceptions as railroad rolling stock).

4. Large pieces of second-hand equipment for intermittent use and some specialized types of equipment with very high initial prices appear particularly suitable. Examples are special grinding machines, special honing equipment, cranes, etc.

5. Second-hand equipment to be used for maintenance is also suitable for developing countries. The productivity of maintenance equipment is not a factor of great importance since most of it is used only part of the time.

6. Standardization problems should also be given proper consideration in a policy for the import of second-hand equipment in developing countries. A great variety of makes, no matter how sound individual pieces of equipment may be, multiplies the already difficult problems of spare parts, maintenance and repairs.

7. Measuring tools and equipment, the accuracy of which is not impaired through use (e.g., scales) represent suitable second-hand equipment.

8. Some types of used equipment should clearly not be considered for use in developing countries. A good example of such equipment is first-generation computers which use a large number of vacuum tubes, the life of which is limited and which are often difficult or impossible to find replacements for.

Some Bargains

In the chemical industry in industrialized countries, equipment is often made available on the second-hand market not by product changes but by a changeover from batch to continuous production, due to increased market demand. This used equipment can be quite satisfactory for smaller markets.

In the textile industry of the United States, it has become unprofitable for manufacturers, with a very few exceptions, to produce specialty fabrics. Integrated plants manufacturing such fabric, disposed of it in their entirety, can often be used to economic advantage.

Among machine tools, equipment which is in sound technical condition, and in addition can be retro-fitted with numerical control, is also often a bargain obtainable at a much lower cost than that a buyer would have to pay for a new numerically controlled tool.

Maintenance

There is no clear-cut difference in the magnitude and nature of maintenance problems between new and second-hand equipment. A

knowledge of electrical control circuits, hydraulics, pneumatic systems, and electronics is often necessary for the maintenance of modern machinery, and sometimes such modern machinery stands idle for long periods of time in developing countries where these skills are still in short supply. On the other hand, the older the machine, the greater are the risks of breakdown and consequent losses from reduced production and larger repair costs. While all equipment requires more maintenance with age, the increase in maintenance costs is not proportionate to age.

In general, spare parts are more easily available for new than for old equipment. But in many cases where technological improvements have been few or where deterioration of parts is negligible (process equipment used in the chemical industry, such as vessels and tanks which have no moving parts) spare parts present no problem. Producers of machinery generally stock repair parts for machines of their manufacture for at least ten years. Some manufacturers of textile machinery continue to make spare parts for machines they produced forty years ago.

With few exceptions, no service arrangements are made in the case of exported individual pieces of second-hand equipment. For major plant components service arrangements are found somewhat more frequently; and for complete plants, a clause of the contract will sometimes provide for the contractor's responsibility for maintenance for a period of time.

Prices

While no definite figures can be given for the cost of second-hand equipment as compared with that for new, some generalizations can be made for the United States on the basis of market experience:

Standard metalworking tools such as lathes, grinders, brakes, millers, and drill presses in good operating order, but not rebuilt, can be obtained in the United States at 25-45 percent of the cost of new equipment. Rebuilt, they sell for 65-75 percent of the cost of new equipment. Heavy and special metalworking machinery such as boring mills, forging hammers, presses, and vertical turret lathes in good operating order, but not rebuilt, sell at 30-50 percent of the cost of new equipment. Rebuilt, the cost goes up to 40-60 percent of the cost of new equipment.

Chemical process equipment, in good operating order but not rebuilt, will sell for 25 percent to as much as 50 percent of the original replacement cost for mechanical equipment, and up to 70 percent for plate fabrications.

Passenger cars will usually lose one-third of the original value after one model year, one-quarter more the following year, one-fifth again by the end of the third year, one-sixth the next year, and so on. The general rule of depreciation for trucks is one-quarter loss of original value the first year, one-fifth the second year, one-sixth the third year, one-seventh the fourth year, and so on until a level is reached below which the price never drops as long as the truck can run and be repaired.

Packing, transportation, and installation costs are usually the same for second-hand machinery as for new equipment.

In the second-hand machinery market, prices fluctuate widely as the result of marked changes in supply and demand. This can be explained by the fact that the second-hand equipment market is supply rather than demand oriented. Changes in demand are not followed by corresponding changes in supply, which makes it very necessary that intending purchasers should be sufficiently familiar with market conditions to make purchases at the most attractive prices.

Experience in Developing Countries with Second-Hand Equipment

The experience in developing countries with the utilization of second-hand equipment gives numerous examples of both successful and unsuccessful applications. Restrictions on the importation of second-hand equipment exist in some of the Latin American countries, India, Iran, Iraq, Somalia, Turkey, etc. The governments of all these countries were requested by the United Nations Center for Industrial Development to give reasons leading to such restrictions. The major reasons were:

1. Difficulties in obtaining information regarding the technical and economic aspects of second-hand machinery, and a lack of technical experience in the acquisition and evaluation of second-hand equipment;

2. Non-availability of spare parts and maintenance problems;

3. Opportunities for smuggling out foreign currency through transactions involving second-hand equipment;

4. Lack of adequate guarantees, as compared with new equipment.

Another reason mentioned was the possibility of affecting adversely the domestic equipment manufacturing industry. One of the reasons not mentioned in the replies but discussed in several studies on the subject was a feeling that second-hand equipment was in some sense

inferior, and that its use was therefore derogatory to national pride. This impediment is an expression of value judgments which do not lend themselves to scientific discussions. It can be stated, however, that second-hand equipment is used to considerable advantage in developed countries, and that developing countries need not deprive themselves of similar advantages.

A good illustration of an older and less productive plant still able, because of lower labor costs in this case, to successfully compete with modern plants operating in industrialized countries is the example of a foundry in South America exporting castings to the United States. Another example is that of a firm in Asia, affiliated with a larger European concern, from which it bought a used semi-automatic machine for making wood screws. The Asian firm, working under conditions of low labor rates, not only undersells the European company in its own country, but also exports to neighboring countries at a price lower than its European associate. When, however, the productivity gap between the older machine and the machine of modern design is considerable it often cannot be compensated by low labor costs. For instance, a paperboard factory in the West Indies employing used machinery was not able to compete with United States factories despite low wages.

A plant which manufactures a product of a quality unacceptable in one country can operate successfully in aother. For example, used batch-dyeing equipment in a textile plant in a Central American country could not be made to reproduce the exact shade of color from one batch to the next. Still, it operated successfully because local consumers did not object to these variations. The case of a steel mill in Latin America was less fortunate: the steel plate and sheet produced by this mill could only be marketed in the country with the protection of a very high tariff on the importation of similar products. The mill could only produce plate and sheet of one meter width, and of uneven thickness.

A plant may become obsolete in one country due to the appearance of new, less expensive raw materials. In another country where the original raw materials are abundant, it can still remain competitive. Thus, a synthetic rubber plant using ethyl alcohol was made obsolete in the United States by the appearance of a cheaper process using refinery gases as raw material. The entire plant was transferred to an Asian country where ethyl alcohol was cheap and abundant. It has operated without any special operating or maintenance problems since its construction.

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INADEQUACIES IN TECHNICAL INFORMATION CHANNELS

W. Paul Strassmann

[The transfer of technology to developing countries moves through several types of channels for personal contact, each of which has its peculiarities and weak points.]

Technological information is not an ordinary commodity, and ordinary markets will not transfer it efficiently from developed to poor countries. The uncertain value of information not yet owned, and the difficulty of owning information exclusively, have led to a complex and still imperfect network for its international diffusion. In part this network consists of schools, libraries, technical and trade journals. In part it consists of inquirers and responders who have been compared to a system of relay stations.

A general feature of international technical transfer is that these relay stations are not closely coordinated. This lack has the advantage of flexibility, but means that a given problem is solved piecemeal at the various stages; the problem is defined from the point of view of each party in turn, that is, too narrowly. Entrepreneurs pose the problem of how to buy and run manufacturing equipment. Their engineers, machinery sellers, consultants, foreign patent owners, research institutes, and government agencies either offer a solution or pass the problem on. Considerable misinterpretation of questions and distortion of answers is inevitable, because of uneven specialization and conflicts in outlook. The following conditions are typical.

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The entrepreneur. He wants to run his enterprise the way it should be done, yet his suspiciously uncertain attitude toward information tends to minimize flows. Receptiveness to new ideas may come when a son returns from engineering school, or through sales lost to a modernized competitor. In any case, machinery sellers are likely for a while to be the main technical contact, and the first problem of communication is for them to gain the trust of the entrepreneur. It seems that face-to-face contacts to establish trust are the most effective, and are necessary in the transfer network.

Information about manufacturing is immensely complex and heterogeneous. If enormous libraries were shipped abroad the knowledge would get there, but with no effect on productivity. Books, technical journals, and manuals must be complemented by experience, and experience in industrial operation is precisely what underdeveloped countries lack, and seek.

Machinery suppliers. Salesmen and manufacturer's agents may well be the most extensive carriers of technical information. Often the crucial transfer occurs through the manufacturer's follow-up service. But transactions through this channel tend to be off-the-shelf, not creative reformulations of problems; horizons are widened to include available models, but little more. The entrepreneur, through ignorance and/or a monopolistic position in his market, often fails to make the demands or supply the information that could lead to redesign of machinery, and accepts the first working model offered.

Staff engineers. Most engineers are trained to go by the handbook, not to experiment or question assumptions. Foreign textbooks used in production engineering are likely to encourage thinking in terms of large volumes, mechanization, and standard materials rather than of conditions found in underdeveloped countries. But if self-sustaining industrialization is to get underway, engineers must be willing and able to improvise. Behind the ingenious adaptations of machines to local conditions one can usually find a man undazzled by and perhaps unfamiliar with lavish technical standards abroad, the rare specimen who has been carried away by enthusiasm for the technical details of his industry.

Consultants. Consulting engineers assume responsibility for setting up a workable enterprise, and tend to show more interest in adaptations. This sense of responsibility, and a greater receptiveness to information on local problems, does not guarantee highly adaptive behavior, however. When planning layout, supervising construction, etc., the consultants usually consider familiar patterns—i.e., the practice in industrial countries—to be satisfactory if they are feasible at all. Their adaptations are most likely to consist of the acceptance or rejection of components developed by manufacturers, not of

invention or redesign of methods. Their contribution is "know-where," far more than "know-how."

Management consultants concentrate on improving internal organization of the firm. They ask about production planning, inventory control records, possible simplification of clerical procedures, worker training, wage incentives and division of responsibilities. If there is high labor turnover, in which departments? Given this kind of information, solutions are usually obvious. But many organizational reforms are difficult to introduce and make acceptable to inexperienced workers. Managers in several Mexican firms, for example, reported that savings which might have resulted from recording hours and output in detail, as recommended by consultants, were more than eaten up by delays resulting from the record keeping, and that so much data was distorted that it led to confusion and even wrong decisions.

License agreements. Agreements giving entrepreneurs the right to use processes protected by patents in developed countries are often an important information channel. Access may be provided to everything from secret formulas, working drawings, machine times and costs, to advertising copy. The right to observe in the licensor's plants and to discuss and sketch or photograph the process is important. Licensees usually get the right to all improvements in the product or process covered, though not to entirely new developments. Licensor representatives may help initiate production, inspect periodically, and send out samples for testing.

According to most agreements, however, the licensor initiates and controls the flow of information. The rationale is that to leave discretion in these matters to the licensee who lacks adequate knowledge would lead to useless and poorly-organized transmittal. This practice does not encourage fundamental readjustments of production methods or redesign of products. Most of the licensor's return will be a percentage, typically around 5 percent, of net sales, in addition to income from selling components. Thus, the licensor hopes to share in the licensee's success; but this is not reinforced by a similar sharing in responsibility for failure.

Research institutes. Few institutions can match the potential of research institutes as problem recognizers and definers, local information seekers, and selectors of best sources of information abroad. Direct contact with American or European industrial research organizations implies access to channels particularly sensitive to possibilities for adapting knowledge to local conditions. If an underdeveloped country has a research institute affiliated with one abroad, the latter is likely to have better facilities than its counterpart for quickly sifting a vast literature, sampling expert opinion, and evaluating alternative approaches. The established Western research laboratory may

also be able to find companies using processes of interest and, given the right personal contacts and institute prestige, it can open doors and files.

Many Western consulting laboratories serve Latin American customers. Much of this work is routine testing or analysis, however, although some large laboratories also supply economic surveys, management counseling, and engineering design. In addition to the impediments arising from a lack of acquaintance with such facilities, and from the foreign exchange costs involved, the difficulty with foreign research institutes is that they cannot work closely with their distant client firms. Yet research, like vocational education, must be linked closely to the firm to be effective.

Research institutes in developing countries are usually (perforce) government sponsored and subsidized, and they face special problems in their relations with local private firms. Most businessmen recognize the value of the institute and they are for it in a vague way, but are frightened of its practice. If it is felt within a private firm that the firm has something to conceal from the government, the firm will avoid sharing information with such an institute, regardless of its scientific excellence. If the institute is to succeed it must keep begging industry for contracts, yet it must keep every droplet of information about firms a holy secret. In fact, few such institutes do engage in promotional activities to "sell" their services (as do American laboratories), and when they do so the going is not easy. A Puerto Rican manager probably gave a typical response to a first contact: "I spent years building up this business... and now these characters come and say 'Let me solve your problems.' They never saw a plant like this before!" To try to persuade such men is not an activity compatible with the traditional attitudes of many governments toward private business.

Government assistance. The United Nations and governments of developed countries have assumed much responsibility for international transfer of technology. But with respect to manufacturing, they do not usually add a new channel; most international assistance consists in subsidizing the activities already described. The difference is that the manufacturer does not approach the transmitters of knowledge directly; he goes instead to a productivity center, a ministry, or a foreign technical mission.

Direct assistance by governments of developing countries to their own manufacturers is rendered difficult by the heterogeneity of industries; few technical problems are of interest to a substantial number of them. Adoption of particular solutions to such problems depends on technicians who can work out strategies in each situation in the major and minor branches of industry; but few governments

in underdeveloped areas can afford to have such specialized technicians on the permanent staff solely as consultants.

Nevertheless, some governments, as in Puerto Rico, try to fill the need. Its Industrial Research Department will test minerals, water, air purity, etc., for prospective investors; its Industrial Engineering Section advertises an ability to plan complete layouts in some fields, and engages in trouble-shooting activities; its Economic Development Administration has a variety of consulting firms on retainer so that specialized expertise can be brought in without delay. All these subsidies in kind could as well be given in cash; by assuming responsibility for specific problems, the government not only tries to insure the unknown but implies, reassuringly, that industrial ailments are minor and responsive to routine cures. India has also emphasized direct government technical assistance: demonstration vans with modern equipment go to village artisans; Small Industries Service Institutes provide extension workers to solve problems; etc. Critics allege that the extension technicians cannot give good advice on many problems, while specialized programs find too few takers.

New Approaches

In 1965 the United Nations Advisory Committee on the Application of Science and Technology to Development (UNSCAT) considered setting up groups to monitor and stimulate activity in "concerted attacks" on selected problems. In the field of manufacturing, the Committee recommended general support for techniques that would be relatively small in scale and labor intensive, using indigenous materials and versatile equipment. It also proposed pilot projects for "technology transfer centers" and case studies of transfers in selected industries. Subsequent conferences and activities indicate that the subject is gaining increasing attention.

It would appear that actual improvements in technology transfer are less likely to result from new general formulas than from pragmatically guided evolution. Some transfer channels which will prove well worth encouraging may be unforeseeable from abstract generalization. Measures for improvement will not drip from their most abstract formulation, growing like a stalagmite; rather, the transfer system must be built up like a coral reef, for and by its participants.

[Adapted from Chapter 2, "The Network for Diffusing Manufacturing Technology Among Nations," Technological Change & Economic Development: The Manufacturing Experience of Mexico and Puerto Rico, 1968, pp. 24-60. © 1968 by Cornell University, Ithaca, New York. Reprinted with Permission of Cornell University Press.]

THE TECHNOLOGICAL BALANCE OF PAYMENTS

C. H. G. Oldham, et al.

[The present technological balance of payments indicates that transactions are mostly among developed countries. A new international agency is proposed to help increase the flow of technology to developing countries.]

It is only recently that attempts have been made to measure the transactions in the international market in the licensing of patents and other "know-how" agreements, and there is not yet any agreed body of definitions and methods for the compilation of such statistics. Only a part of the total flow of technological information between enterprises is recorded by present methods of data collection. Particular difficulties are encountered in recording transactions between subsidiary and parent companies. But a number of developed countries now publish annual statistics of their "technological balance of payments," and with the aid of these figures and additional information from the Organization for Economic Cooperation and Development (OECD), very tentative estimates have been made of the world pattern of transactions. These suggest that the total world flow of payments, excluding transactions with and among socialist countries, amounted to about $1 billion in 1964.

The United States accounted for over half of the receipts but a relatively small proportion of the payments, Western European countries for about 60

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percent of the payments, and Japan for about 13 percent. The developing countries together accounted for less than 10 percent of the payments and a negligible proportion of the receipts, and Japan for only 1 percent of the receipts.

Technological Balance of Payments: Estimates for 1964

(Percentage of world total receipts or payments)[a]

	Receipts	Payments
United States	57	12
United Kingdom	12	11
Germany, Federal Republic	6	14
France	5	11
Other Western European Countries	18	25
Japan	1	13
Other Developed Countries	1	6
Developing Countries	-[b]	8
Total	100	100

a/ Excluding transactions among socialist countries and between those countries and developing countries.

b/ Receipts of developing countries were less than 0.5 percent.

The example of Japan is instructive. The rapid growth in licensing and know-how agreements have been especially significant: payments for imports of technology have been increasing at a rate of about 20 percent per year. Over the last 6-8 years the cost to Japan of imported technology has averaged just over 0.2 percent of the gross national product (GNP) and about 25 percent of indigenous industrial research and development expenditures. Government control of the terms and conditions of technical agreements has been an important feature of the Japanese system.

Successful efforts in development would (as in the case of Japan) involve a rapid increase in payments for acquiring technology, with implications for the future pattern of this market. Payments from developing countries constitute only a small part of the total transactions at present, yet the need of developing countries for more advanced technology is great though it is not yet reflected in effective demand on the world market. They have little or nothing to offer in the way of reciprocal flow of technical know-how, and have limited financial resources, especially in foreign exchange. Exhortation will not change this situation, nor the requirements of international

competition. A great deal of know-how in advanced technology is concentrated in the hands of those large private firms in developed countries which perform most of the industrial research and development. Firms and other organizations which innovate successfully and diffuse their innovations are entitled to be rewarded for their efforts. To transfer technology to a developing country is especially expensive as it involves larger and longer training programs. An improved and more comprehensive international mechanism may be required to help developing countries acquire foreign technical know-how.

One way to accelerate the transfer of technology from private firms to developing countries would be to adjust the market mechanism so that both parties have a greater interest in the successful conclusion of know-how agreements. An appropriate mechanism could be an International Technology Agency. Any such agency would have two main functions, one technical and the other primarily legal. The technical function would be to assist developing countries to gain information about technologies most appropriate for their needs, which would be provided largely by consultants selected on the basis of technical qualifications. It would supplement, not supplant the work of existing consulting organizations.

Once a specific technology had been identified, the agency would then act in its second function of intermediary in the negotiation of contracts, assisting by the application of its legal expertise. The agency might also be able to handle negotiations with state licensing organizations, such as the "Litsensintorg" in the U.S.S.R., when requested to do so by clients.

Two ways of financing transactions can be envisaged. The enterprise supplying the technology could be recompensed largely by payments from the agency, which would draw its funds from contributions by donor countries and a small percentage contribution by importing enterprises. However, such a scheme might meet opposition on the grounds that money from one donor country would be used to recompense an enterprise in another donor country. An alternative scheme would be for the government of the country whose enterprise supplies the technology to provide the compensation directly. Thus, if a French technology, for example, were selected by the developing country, then the French Government would compensate the French enterprise and in turn receive partial compensation from the receiving country.

Such an arrangement could be advantageous in several ways: it would be valuable to enterprises in developing countries, since it would help them acquire appropriate technologies at a greatly reduced cost. The costs of any such scheme would be borne mainly by

taxpayers in donor countries, but the scheme could be of interest to donors as a form of aid channeled into industrial firms in their own countries; it would benefit the enterprises and consultants supplying technologies by increasing the amount of their business, with adequate compensation, beyond what they could expect without such intergovernmental supporting arrangements.

[Excerpted from "Trends and Problems in World Trade and Development: The Transfer of Technology to Developing Countries, with Special Reference to Licensing and Know-How Agreements," a study prepared at the request of the secretariat of the United Nations Conference on Trade and Development for their second session, New Delhi, 1 February 1968, pp. 4-7. UN Doc. No. TD/28.]

LOCUSTS

SWARMS OF DESERT LOCUSTS ATTACK A TREE
IN AN ORCHARD IN MOROCCO.
(PHOTO: FOOD AND AGRICULTURE ORGANIZATION
OF THE UNITED NATIONS)

THE LOCUST MENACE

C. F. Hemming

[Plagues of locusts, causing great damage to crops in much of Africa, the Near East and India, are better understood than in the past. While man has developed new weapons against the locusts, the threat of plagues is ever present and needs constant watch.]

The Desert Locust has long been considered one of the world's most serious agricultural pests. It can invade a total area of 11 million square miles, which is 20 percent of the world's land surface and includes the whole or part of 65 countries. All the continents of the world, except Antarctica, are still liable to attack by these or other species of locusts and grasshoppers.

Tremendous damage may occur in a single season; e.g., at the end of 1954 and the beginning of 1955 damage estimated at £4,500,000 was done in Morocco [£1 = $2.40], mainly to citrus plantations. In 1958 a single very large swarm in the Somali Republic covered a total of 400 square miles, or about a quarter of a million acres. As it is known that there are usually between 100 and 200 million locusts in a single square mile of swarm, this swarm may have contained 40,000 million locusts.

During periods of high activity and migration a locust may eat its own weight in food each day, and though this is only about two grams a large swarm of such dimensions would require about 80,000 tons of food a day. When one considers that this amount of grain would be enough to feed 400,000 people for a

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year, one can easily see how serious locust plagues can be. Apart from the damage locusts can do by eating, they sometimes settle so densely that they weigh down and break the branches of trees and plantation crops, such as coffee, which they do not usually eat.

The Phase Theory and Plagues

As locust plagues were only periodic, it has long been wondered where the locusts went to during the quiet spells, which are now called recessions. The phase theory, formulated by Sir Boris Uvarov in 1921, accounted for the apparent disappearance of the locusts after a plague by showing that a relatively small number still existed as grasshoppers, with their shape and color sufficiently changed for them to be easily mistaken for a completely different insect. The fluctuations between plagues, when many countries are infested by swarms for several years, and recession periods, when there are either no swarms or only very few in one or two countries, have made man look for some kind of regular periodicity, but this has not been found.

The phase theory initiated the search for the places where and the conditions under which large numbers of locusts would be crowded together after successful breeding and thus change to the swarming phase. Biogeographical studies conducted by the Imperial Bureau of Entomology revealed that plagues of the Red Locust and the African Migratory Locust had started in relatively small areas in Africa. These areas were designated outbreak areas. Ecological field studies enabled the outbreak areas to be recognized. It is intersting to note that though the areas for the two species are spearated by several thousand miles they are both seasonally flooded grasslands. It is in these outbreak areas that the solitary locusts are largely confined between plagues. International survey and control organizations were later established in both these areas, and since then there has not been a plague of either of these species.

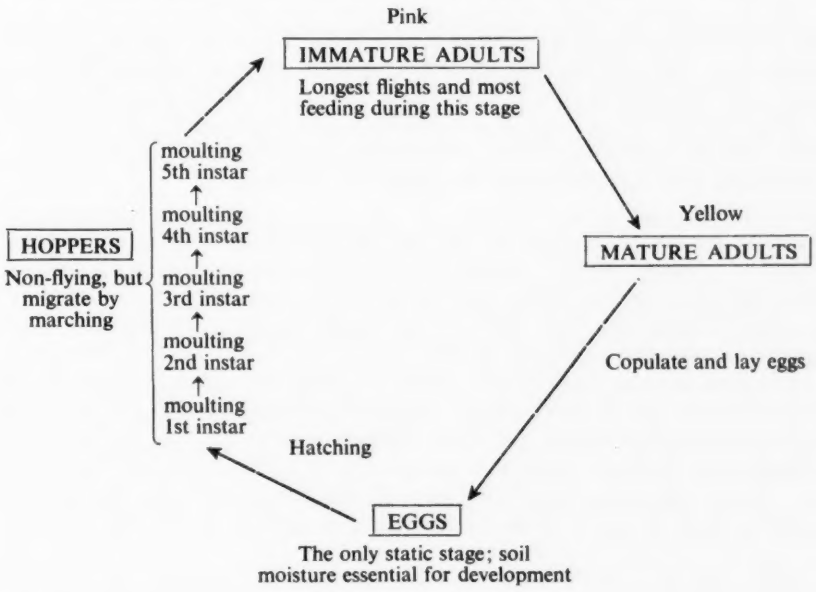
Biogeographical studies on the Desert Locust have shown that it has no comparable permanent outbreak area; consequently it has not been possible to establish a single international survey and control organization to prevent the development of plagues. The way in which plagues of the Desert Locust develop is very complex, but there is no doubt that the two main factors are meteorology and the gregariousness of locusts. Particular weather systems can gather non-swarming locusts together; and rain in the semi-arid regions that this locust inhabits provides breeding conditions which enable the locusts to multiply. Before swarms can be produced this increase must usually be repeated in successive seasonal breeding areas. Swarms are formed whenever large enough numbers of locusts are crowded together, and in nature this further crowding is produced by a shrinkage

of the area which provides suitable conditions; for example, at the end of the rainy season the supply of green and palatable food plants gets progressively less and the locusts are thus concentrated. The fact that such combinations of favorable meteorological patterns do not occur at regular intervals of seasons or years accounts for the absence of any predictable frequency in the occurrence of locust plagues.

Even though much of the area in which Desert Locusts live is dry for the greater part of the year, they usually arrive at the same time as the rain. They can thus utilize areas of ephemeral vegetation resulting from the rain, and the swarming of this species is therefore not restricted to small permanent habitats as is that of the African Migratory Locust and the Red Locust. Even during recessions Desert Locusts occur over very large areas, over which a seasonal watch must be kept every year in order to detect any dangerous increases in numbers as early as possible. The extent of the invasion area and the recession area of the Desert Locust is vastly greater than outbreak areas of the Red Locust and the African Migratory Locust.

In addition to these three species there are several other true locusts, including the Brown Locust in southern Africa, the Moroccan Locust in the Middle East and around the Mediterranean, the South American Locust and the Australian Plague Locust. The Desert Locust is the species which presents the worst problem to man.

The life cycle of gregarious Desert Locusts may be summarised thus:



Desert Locusts lay their eggs in batches. The preferred soil for laying is sandy and damp with the top inch or so dry. The eggs are bound together with a frothy secretion that hardens and forms into an egg pod. Each is about $1\frac{1}{2}$-2 inches long and may contain between 20 to over 100 eggs. Locusts can lay eggs several times before dying, and thus have the capacity to multiply very rapidly. Incubation usually takes two to three weeks and the locusts emerge as wingless hoppers. After passing through several instar stages (i.e., moultings) they go through a final moult and emerge as winged immature adults. As the number of such fledglings increases, small groups are formed; they gradually join together and form a swarm of the new generation, which is ready to begin its migration to the next season's breeding area.

Migration

The capacity of locusts to migrate is one of their most important characteristics, and this is particularly so of the Desert Locust for which migrations of 1,000-3,000 miles between successive breedings are not unusual. Flight activity is affected by temperature; when the shade temperature is above about 60°F with the sun shining, or 75°F in cloudy conditions, sustained flight is possible, and is in fact the main activity of immature adult locusts during the day. By means of light aircraft, swarms have been followed for days and even weeks, during which daily flights of 50 miles have been found to be typical in warm sunny weather. However, under cool conditions, such as are found in the highland areas of Ethiopia and Kenya, swarms may remain more or less stationary for several days. Under such conditions damage to crops can be particularly serious.

A locust can fly at an air-speed of 10-12 m.p.h., so it cannot make progress against winds exceeding this speed. Individual locusts take off into wind but if the wind speed is such that they begin to drift backwards they turn downwind, and in general swarms migrate with the prevailing wind. Swarms usually migrate as discrete bodies leaving remarkably few stragglers behind.

Numerous observations have shown that locust swarms are of two main shapes. Under cool conditions, in the early morning and evening, swarms usually fly close to the ground and have a characteristic flat top. Such swarms are said to be stratiform. Under hot conditions, usual throughout much of the day over most of the Desert Locust invasion area, there are often strong up-currents of air which carry the locusts up to several thousands of feet above the ground, often in a series of towers. These swarms are cumuliform, with locusts flying at a much lower density than in the shallow stratiform swarms. Even though many are at a great height above the ground it is usual to find large numbers on the ground beneath the swarm;

this is because migrating locusts do not spend all their time flying and there are always some taking-off while others are landing.

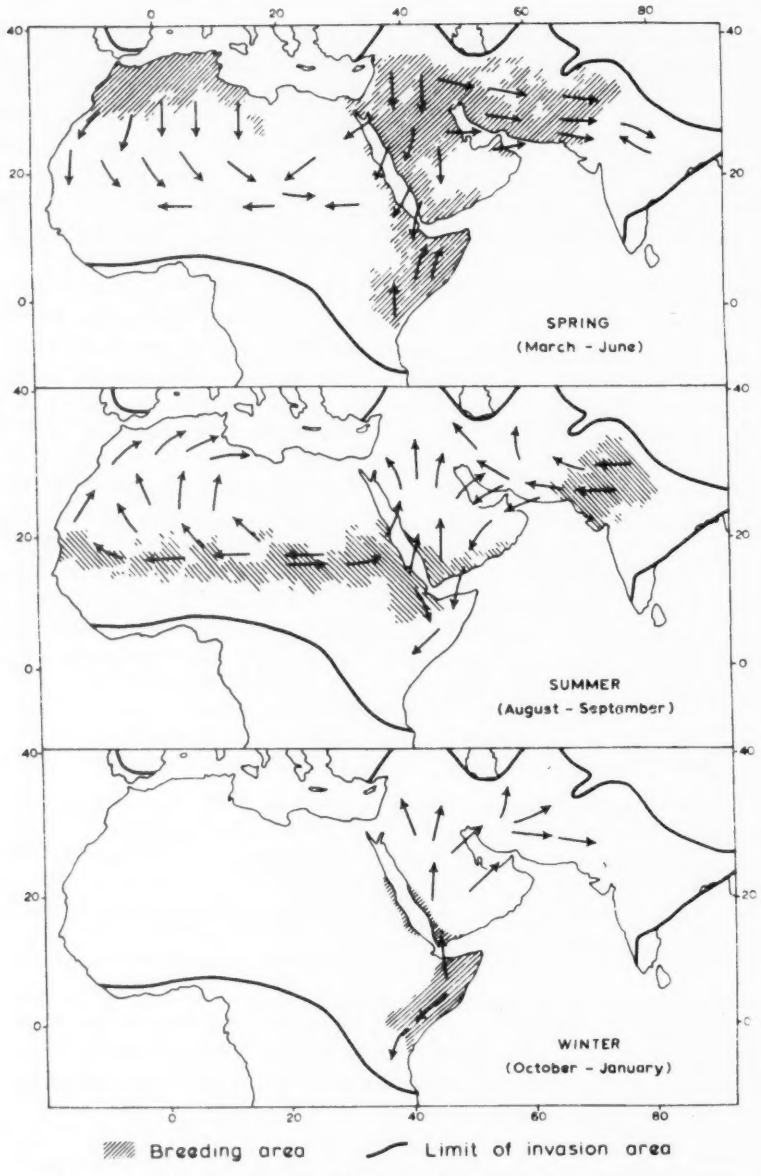
The downwind migration of Desert Locust swarms results in their movement towards and subsequent concentration in areas where low-level winds meet and rain consequently falls, so that adult locusts are continually arriving in just those areas where the soil is moist and the vegetation is green; these being essential requirements for successful breeding. Thus, though the Desert Locust occurs in many desert countries it usually arrives during the rainy season when these countries are at their least desertic.

In the Desert Locust invasion area the major weather phenomena are seasonal; therefore, the major migration patterns are also seasonal. The to-and-fro movement of these meteorological systems during the year results in a circulatory pattern of migration such that, for example, the swarms produced in western Africa south of the Sahara in the summer migrate northwards and breed in north Africa in the following spring and thus give rise to new swarms which then migrate southwards to the summer breeding grounds. The accompanying may shows in a simplified form the spring, summer, and winter breeding areas of this species and also indicates the main directions of movement of swarms produced in them. Superimposed on the major seasonal trends are short-term variations, and therefore, while the major seasonal migrations are known and predictable, the day-to-day movements depend upon erratic local conditions which may vary from hour to hour.

Control by Natural Factors

A female Desert Locust from a swarm may lay three pods, perhaps totaling some 200 eggs. Thus if we assume that a swarm consists of equal numbers of males and females there is the theoretical possibility of a multiplication rate of 100 times in a single generation. Despite this natural fecundity such multiplication rates are fortunately never even approached.

Partial fialure of breeding is common where there is unreliable seasonal rainfall. When a female locust is ready to lay her eggs she can only retain them for about three days; if a suitable laying site is not found the eggs must then be jettisoned, and they quickly shrivel and die. Even if the eggs are laid in soil that is just moist enough for laying, subsequent desiccation can still occur; or, egg fields may be destroyed by flooding or by running water after heavy rains. Egg pods in sandy soils are sometimes exposed by wind erosion and experience desiccation. Even after the eggs have hatched the weather remains a serious danger; the young hoppers have often been seen to die when they cannot find any plants upon which to roost.



MAP: Spring, summer and winter breeding areas of the Desert Locust and the major directions of migration of the swarms produced in them.

Apart from these weather factors there are numerous predators, parasites and diseases which attack the locust at all stages of its life cycle. Hoppers are particularly vulnerable during the first few minutes after hatching and in Kenya the author has seen ants waiting at the top of an egg froth-plug and carrying away all the hatchlings.

Losses on migration are one of the natural hazards of a locust's life. The winds upon which locusts migrate sometimes fail to carry them to a suitable breeding area. For example, the migration from the Canary Islands to the British Isles in 1954 took the locusts into areas quite unsuitable for breeding. Even when locust migrations follow the normal routes from one seasonal breeding area to the next many die on the way.

Despite this considerable natural mortality, very large swarms and indeed groups of swarms of the Desert Locust and of certain other species can develop. Today, enormous campaigns are conducted against the Desert Locust, using modern concentrated insecticides, highly efficient spray gear, and both aircraft and ground vehicles. But a systematic approach and modern technology have not been in use long in the fight against locusts; new techniques and products are still being developed.

Until quite recently man has largely ignored the breeding places except where they occurred in cultivated areas. Recent analysis has shown that only eight percent of the economic damage done by locusts is caused by hoppers in the breeding areas. The ancient policy was therefore one of defense rather than offense. When a swarm arrived in a cultivated area the local farmers tried to prevent it from settling on their fields by lighting fires, shouting, and banging tins and drums.

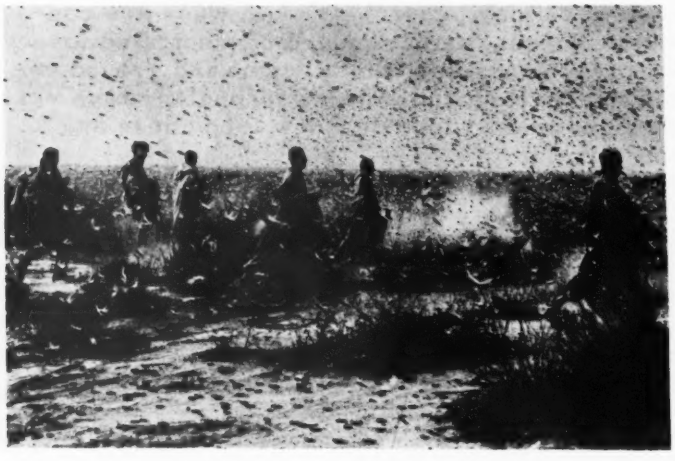
One method of control consisted of ploughing the fields after locusts had laid in them, thus exposing the eggs to desiccation. Another method was to dig up the egg pods, and about 35 years ago the villagers were paid to do this in India and vast heaps of egg pods were gathered together and burned.

To kill the hoppers attempts were made to direct as many as many as possible into trenches where they were buried or burned. In some countries hopper bands were sometimes destroyed by scattering straw over their roosting sites at night and then burning it. Occasionally the cultivators and villagers just joined together in beating the hoppers to death with twigs and branches; this probably constitutes the most primitive and ineffective method of control.

The best of these early methods was that of driving the hoppers into specially prepared trenches using barriers to direct them. This

method was the first to be used on a big scale away from the cultivated areas, and thus ushered in the era of attack rather than defense against the locust.

Campaigns against hoppers in their breeding areas became much more effective when chemical methods of control were developed. The earliest poison used extensively against hoppers was sodium arsenite. Mixed with some carrier which the locusts would eat, such as sawdust, chaff of various kinds, chopped maize cobs, or wheat bran, it constituted a bait which was spread on the ground in the path of the advancing hopper bands. Later, experiments were conducted to see whether the bait would be made more attractive to the hoppers by addition of water or molasses. All these baits killed large numbers of hoppers but occasionally unconsumed arsenical bait caused cattle deaths.



Baiting, such as that pictured here in Morocco (Photo: FAO), continued for several decades as the principal method of killing hoppers. Later, chemicals were developed as insecticides for specific purposes. The first and most important of the newer insecticides used against hoppers was the gamma isomer of benzene hexachloride (BHC); a bait made with wheat bran containing about 0.1 percent gamma-BHC has been used in very large quantities.

During the 1950s a very simple sprayer operated by the pressure of the exhaust gases of a vehicle was developed. Known as an exhaust nozzle sprayer, it produces a very fine spray of insecticide which is drifted downwind by even a light breeze. It can be mounted on a small vehicle like a Land Rover which can carry about 30 gallons of insecticide. If this insecticide is concentrated, cumulative in the locusts and persistent, even a very small team with a single vehicle is a very powerful control unit. Dieldrin has proved to be an insecticide of this type and when applied at 20 percent in oil by exhaust nozzle sprayer it can be used either to spray hopper bands directly or to spray vegetation in long strips. In the latter case, the droplets of insecticide which drift on to the vegetation poison any hoppers which feed on it, even though the deposit rate of dieldrin may be only

2 ounches per acre. Owing to the persistence of dieldrin the lethal quality of such a strip will last several weeks. As groups of hopper bands tend to move in the same direction, applying the spray in a series of parallel lines across the direction of march is an efficient control technique. The cumulative nature of the insecticide means that even if a hopper eats less than enough contaminated vegetation to kill it on one spray line it will take up more on the next line, and so on until it is killed. The laying down of such spray lines at intervals of as much as 5 miles has been recommended when the hoppers are in the early instars, or at half this distance if the infestation is not discovered until the third instar. This method of killing by spraying the vegetation has great advantages in that it removes the need to search for every individual hopper band; the hoppers themselves find the insecticide. It is also very quick and economical. [Note: dieldrin affects the milk and fat of cattle grazing in treated areas.]

The use of aircraft against locusts has gradually become more general since the second world war. They have many uses in anti-locust work because they alone can match the mobility of a migrating swarm. Aircraft can be used instead of ground vehicles to lay down lines of spray against hoppers. Because of their speed they can treat large areas in a short time, and as infestations are all too often not discovered until the hoppers have attained the later instars, speed can be vital.

Aircraft have proved particularly valuable in spraying swarms in flight. They can carry large amounts of concentrated insecticide, and can maintain contact with migrating swarms far more easily than ground vehicles can. The spray is emitted in minute droplets by means of spray gear specially devised for the purpose, and in order to minimize wastage it is necessary to insure that there are as many locusts as possible between the aircraft and the ground. In view of this, and since locusts collect more insecticide when flying than when settled, the best chances for a good kill occur in the morning and evening when the swarms are flying near the ground. In the middle of the day they tend to be cumuliform, and the rising air currents carry the fine droplets upwards away from the locusts, which, being at a low density, collectively constitute a poor target in any case. A striking example of the effectiveness of a modern insecticide, diazinon, applied in this way was the destruction of 180 million locusts with a single light-aircraft load of 60 gallons. This kill is equivalent to a square mile of swarm.

[Excerpted from The Locust Menace. London: Anti-Locust Research Center, Ministry of Overseas Development, 1968, pp. 1-10, 17-22, and 25-28.]

INTERNATIONAL ACTION FOR LOCUST CONTROL

Food and Agriculture Organization of
the United Nations, Rome (FAO)

[Since the Desert Locust does not respect national boundaries, its effective control must necessarily involve international cooperation. Recent efforts to achieve this are described.]

It has been apparent for some time that the geographical scope of the Desert Locust problem is so wide, involving many countries in vulnerability to this menace and in the ability to deal with it, that independent operations at purely national levels could never be effective, except perhaps locally and temporarily. As the migrations and breeding of locusts and their dependence on meteorological factors came to be better understood, the futility of applying control measures in one country and not in another was increasingly recognized.

The earliest efforts at international coordination of both basic research and current information occurred in the Anti-Locust Research Center, founded in London in 1929. The first regional organizations to coordinate national action programs appeared in sub-Sahara Africa. In 1960 the international cooperation for locust control was given a new impetus by the initiation of the Desert Locust Project, sponsored by the United Nations Development Program (UNDP) and carried out by FAO. This Project, originally scheduled to last for six years but extended to 1970, establishes FAO as the international body around which pre-existing and new organizations are grouped in a rather loosely defined structure.

Within FAO, the Desert Locust Control Committee and the Technical Advisory Committee on Desert Locust Control hold periodic meetings and devise FAO strategy. In operational terms, the reporting and

forecasting function performed by the Desert Locust Information Service (DLIS, run on behalf of FAO by the Anti-Locust Research Center in London) is essential; its monthly bulletins, dependent on reports from the nations concerned, provide summaries of the situation throughout the invasion area. These summaries have proved necessary to mapping plans of attack in the affected regions. FAO supports the DLIS (expanding an earlier activity); FAO also sponsors regional meetings of the countries involved, and administers an International Trust Fund for support of research and survey activities. More elaborate regional activities, including regional trust funds, are projected for the future.

As of today, the strength of the various regional organizations, and of the national anti-locust efforts they attempt to coordinate, varies considerably. FAO has been organizing three regional commissions: The Eastern Regional Commission, consisting of India, Pakistan, Iran, and Afghanistan, was founded in 1964. All of these countries (except Afghanistan) have strong national units, and had bilateral agreements for mutual aid in locust control prior to 1964. A Commission for the Near East Region, comprising the Arabian peninsula and its border countries including the United Arab Republic and the Sudan, has been agreed on, but is not yet in operation. For the Northwest African Region—Algeria, Libya, Morocco, and Tunisia—a Commission has been proposed in FAO; prior to its creation these nations, all but Libya having strong national units, will cooperate with the older group to the south (OCLALAV).

The two regional organizations outside the FAO framework are OCLALAV (Organisation Commune de Lutte Antiacridienne et de Lutte Antiaviaire) and DLCOEA (Desert Locust Control Organization for Eastern Africa). OCLALAV, in West Africa, has been in existence for the longest period. Its geographical sphere of operations covers Dahomey, Ivory Coast, Mali, Mauritania, Niger, Senegal, Chad and Upper Volta. It has been highly successful in eliminating the Desert Locust threat in this region. It initially did and still continues to receive substantial technical and financial assistance from France. OCLALAV is represented by an overserver at meetings of FAO committees, and it has cooperated with the Desert Locust Project on survey and research programs.

The DLCOEA was formed in October 1962, a successor to a previous similar grouping. Its members are Ethiopia, Kenya, France (French Somaliland), Somalia, Tanzania, and Uganda. It has an agreement with the FAO to ensure cooperation between the two organizations through consultation and coordination of efforts. In the coming months (autumn 1968) the DLCOEA will be facing its first major challenge, having got its "feet wet" in the Red Sea coastal campaign during the winter of 1967-68. Reports from both sides of

the Red Sea indicate that conditions are ripe for an outbreak of locust plague similar in proportion to that of 1958.

The Desert Locust Project's activities during 1960-66 included: 1) an ecological survey, extending from western Africa on both sides of the Sahara, though the Arabian peninsula, to northern India. As a result, the more probable breeding areas, and the relations of breeding to weather, have been more fully identified for observation and control. 2) The eight existing research centers in the locust invasion area were assisted with funds and equipment, and eleven new centers were inaugurated; technical conferences and other kinds of meetings have helped to coordinate and enliven research efforts. 3) The reporting and forecasting were aided by direct funding to DLIS and by stimulus to the diverse national reporting programs. 4) Training courses were given to about two hundred persons, research fellowships to another hundred, and numerous exchange and advisory visits were sponsored. 5) While actual locust operations remained the responsibility of the nations and regional groups concerned rather than FAO, nevertheless the Project's "operational research" was a help to operations, notably in the creation of a small mobile airplane unit for use throughout the area, in the concurrent testing of new methods as they were used, and in the increased tying in of operations to meteorological reports.

During the Project years, dramatic events occurred in the overall Desert Locust situation. In 1960, when the Project began, a very serious plague of locusts had been raging for over ten years and was still intense. By 1963 the plague had ended, and Desert Locust populations were at an exceedingly low level throughout the invasion area. Similar fluctuations produced by natural causes have occurred before; this particular recession was more extreme than its predecessors as regards the near-absence of swarms. Of the decline which took place in 1960-63, it was possible to say, for the first time in history: "There was evidence that the new control techniques applied on an unprecedented scale had played a major part in bringing about the reduction of the plague" (FAO's Technical Advisory Committee). The plague decreased first in western Africa, where aircraft sprayed dieldrin on a large scale in Mauritania and Senegal to counter new breeding brought on by rains. Later, a new drift-spraying technique was used to good effect in West Pakistan and north India, where locust swarms were greatest at the time.

Over the past 60 years there have been four major plague periods, varying from 7 to 13 years in duration, separated by recession periods of 1 to 6 years. The latest recession lasted about 5 years before showing signs of reversal. In late 1967 there was some revival of locust activity, and the latest DLIS bulletin (September-October 1968) gives indications of new locust swarms in the southern Red

Sea area—Sudan, Ethiopia, Yemen—which could migrate in several directions.

As of 1966 it was thought that control of new swarming populations as they occurred was possible. This conclusion stemmed from particular successes during 1960-66, which held out the promise of a successful suppression of dangerous upsurges during a recession—provided only that properly planned surveying is carried out, and that control measures can be put into effect quickly. There may have been some development of complacency in recession circumstances. In any case, the next few years should show how well the present level of effort and coordination can be maintained, or improved in the face of a new threat of locust plague, and whether current capabilities will prove adequate to the task of stopping the new upsurges before they develop into another ten-year plague.

[Adapted from Desert Locust Project: Final Report. Rome: United Nations Development Program and Food and Agriculture Organization of the United Nations, 1968, pp. 1-131, FAO/SF: 34/DLC. With supplements from the Desert Locust Information Service, Desert Locust Situation Summaries Nos. 123-126.]

DESERT LOCUST SITUATION 1967-68

Based on Field Reports

[During 1967-68 a new plague of Desert Locusts arose in the southern Red Sea area. Despite active control efforts during 1968, the threat remains. Vigorous countermeasures are underway.]

Between September 1967 and September 1968 a new plague of the Desert Locust had come into being, ending one of the longest known recessions, the chief cause being unusually favorable rains in the Red Sea area. In September 1967 no bands or swarms of locusts were reported; some may have existed, but if so they were few and small in size. In September 1968 swarm-breeding was taking place in parts of all the major summer breeding areas. The main concentration of the plague is still in the Red Sea area; heavy breeding is expected this winter and in the spring of 1969 in the countries on both sides of the Red Sea. Incomplete information indicates that crop damage by the Desert Locust during 1968 was not serious; however, serious damage could occur during the coming season, and can only be avoided by stepping up present control efforts. This has now begun.

Locust Surveying

The first indication of a buildup of Desert Locust populations in East Africa came in September 1967 when scattered solitariform locusts were observed along the Red Sea Coast of Ethiopia. During the latter part of November and throughout December isolated but dense bands of hoppers were found within a 200

Summarized from reports from the Desert Locust plague area, supplemented with FAO data.

square mile area between wadis Durama and Akbanazuf. During May-early June 1968, 50 odd swarms were reported in Ethiopia. Many reports were undoubtedly duplicates; a more realistic figure might be 25-30 swarms. At the same time a light scattered population of immature adult Desert Locusts occurred over several hundred square miles.

In Somalia between January and April 1968 scattered first to fifth instar hopper bands were observed in an area of 1,000 square miles along the northern coast. By the end of March it was estimated that between 100 and 200 million locusts were milling about in an area of 100 x 35 kilometers. In the northern Somali peninsula, 10 to 12 swarms were believed to exist in May-June.

Most of the swarms reported in Ethiopia and Somalia during May-early June were relatively small, one to ten square miles, though some were fairly dense. By mid-June several dense, moderate sized swarms had penetrated the Ethiopian highlands near Asmara. Egg-laying was underway at lower elevations and some hopper bands had formed near Barentu, Teseney, and Dire Dawa.

An analysis of operations and resultant locust conditions has revealed that the almost complete emphasis on aerial survey was proven unsatisfactory, as evidenced by the large number of hopper bands later detected in the coastal area of Ethiopia north of Massawa during the winter of 1967-68. Swarms were known to occur in the breeding belt of northeastern Sudan in the fall of 1967; their progeny undoubtedly filtered into Ethiopia to greatly supplement scattered solitary locust populations already known to occur in this region. Although limited ground reconnaissance had been carried out north of Massawa, it was apparently not on a scale sufficient to detect the rapid population buildup. Similarly, undetected breeding occurred in the northern areas of the Somali peninsula in the fall of 1967 and led to the necessity for large scale control during the winter of 1967-68. "Escapes" from this control program (i.e., locusts which escaped being killed) formed swarms which invaded Ethiopia in late April-June 1968 supplementing existing populations.

It is recognized that during the past year emphasis on ground reconnaissance has appreciably increased. However, most vehicles in use were purchased prior to 1962, and adequate ground reconnaissance generally necessitates off-road driving over extremely rough terrain. Vehicles cannot be expected to perform satisfactorily more than a few years, and it is not unrealistic to expect personnel to stay close to established roads and villages when forced to utilize worn-out vehicles.

Locust Control Activities

In the winter of 1967-68 control operations were conducted in the northern coastal areas of the Somali peninsula and the northern Red Sea Coast of Ethiopia by DLCOEA in cooperation with the national units. Apparently control had not been as successful in Somalia as in Ethiopia, judging by the reports of swarms apparently produced in the former area by mid-May, 1968.

During the spring and summer of 1968 control operations were primarily in the Red Sea area; only minor activities were necessary in West Africa or in Iran and South Asia. Operations to the west of the Red Sea, chiefly in Ethiopia but also in Sudan, Somalia, and Kenya, got off to an earlier start than on the Arabian peninsula. In April, aircraft of the Ethiopian government and DLCOEA began work in two areas, and despite certain difficulties in keeping the aircraft flying (or available for locust work) the control activities were continued and expanded to other areas. In May, the Sudan national unit started control operations along the Red Sea Coast. All brain bait of the Ethiopian National Unit was remixed in early June and, along with the remaining supplies of BHC dust, delivered to points where egg-laying was most likely to occur. DLCOEA's supply of both bait and dust were by then practically nil; supplies were replenished later.

Control activities were being undertaken in the winter of 1967-68 on the Arabian peninsula's Red Sea coastal area by the Saudi Arabian National Unit under the direction of the Food and Agriculture Organization of the United Nations (FAO). It is estimated, however, that as many as 50 percent escapes from this operation moved back into the Tihama of north central Arabia to breed. Unfortunately, the FAO locust advisor stationed at Hodeida, Yemen, was forced to evacuate from December 1967 to February 1968 due to the unsettled political situation, and it is doubtful that much, if any, control work was undertaken on the many hopper bands known to be in the Yemen at the time. Similarly, South Yemen (formerly Aden) has only one locust officer who doubles as a General Plant Protection officer and finds it difficult to get into the breeding belt of the Hadhramaut. By the summer of 1968, however, FAO was able to increase the anti-locust efforts in these three countries of the Arabian peninsula with additional expert personnel, equipment, and insecticides, and in all an area of over 200,000 square kilometers was covered.

Situation as of November 1, 1968

Locust reports from outside the eastern Africa region indicate the Desert Locust plague is still confined to countries around the Red Sea. The area to the east and north of the Arabian peninsula appears to be almost completely free of gregarious Desert Locust populations. It is unlikely that this area will suffer a major local population build-up or be invaded by locusts during the next several months.

No serious condition is likely to develop in western Africa in the next six to nine months. The focus of infestation is centered in Mali, with populations still relatively light and scattered. Locusts from this infestation, if uncontrolled, could migrate north towards the Mediterranean Coast of Morocco and Algeria; these two countries are fully prepared for any incursions. Only a few major swarms are believed to have escaped from Sudan towards the west, now mainly positioned in southern Algeria and northern Niger. These could move north; however, if such an invasion occurs it should be of light intensity. The present locust menace in West Africa could conceivably be stamped out this winter.

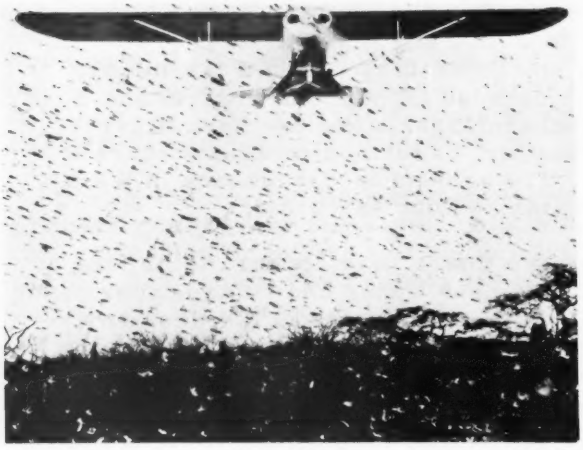
Sudan, except for the Red Sea Coast, now appears to be free of locusts. Breeding has occurred near Tokar and some hopper bands produced. In northern Ethiopia, most swarms in the western escarpment have now been controlled. Escapes have moved to the Red Sea Coast where breeding has occurred and hopper bands formed near Wadi Durama. Due to lack of moisture, suitable areas of egg-laying are much more confined than last year. Additional scattered locusts can be expected to make their way to the Red Sea Coast during the next few weeks. This filtering should be slow, however, due to the present position of the frontal system along the western escarpment.

In the Somali Republic several swarms escaped control and have now moved south into the northern Ogaden of Ethiopia to the vicinity of Awareh and Uardare. Heavy rains and abundant green vegetation have enabled them to disperse widely: a very sizable area of light, scattered locust populations now exist. Widespread breeding can be expected to occur under conditions ideal for a sizable population build-up, and in an area of extreme difficulty for control operations. Their progeny, if uncontrolled, could move south into Kenya about December. They could also invade the southern Ethiopian highlands; though here they can be expected to rapidly disappear as a result of disease brought about through high humidity.

Farther east some swarms have moved south along the Somali Coast from the Mijirtein towards Mogadiscio. Although these could reach northern Kenya in November, their numbers are believed to be small and should not create a major problem either in Somalia or Kenya. In the northern coastal areas of the Somali Republic indications are that the population will be considerably reduced from last year unless further supplemented by swarms from the Arabian peninsula.

This last is becoming more doubtful, as swarms in the southern Arabian peninsula have already begun a northerly movement, and should soon begin to concentrate along the Red Sea Coast and in the Tihama between Hodeida and Jidda. The position of the Red Sea

convergence zone has probably already allowed some incursion of this area by swarms from the Sudan.



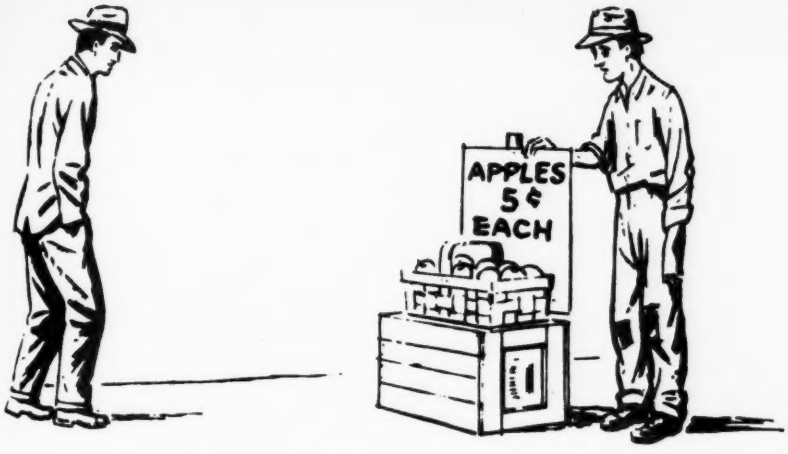
In eastern Africa DLCOEA initiated control operations along the Red Sea Coast of Ethiopia. Known areas of egg-laying and hatching are being sprayed with exhaust nozzle sprayers, and barrier sprays are being applied by aircraft, such as that pictured here in use in Ethiopia (Photo: U. S. AID), utilizing long residual insecticides, between these known areas of infestation and the hills, to prevent hopper band escapes from undetected infestations. Aerial surveys and control operations are being planned for the Red Sea coastal area of Sudan. (Sudan has recently joined DLCOEA.)

In the Ogaden a DLCOEA aircraft is conducting aerial surveys in the Awareh area. Two Ethiopian Ministry of Agriculture aircraft have been dispatched to Dire Dawa for ready access to the Ogaden as soon as surveys reveal sprayable targets. Insecticides and fuel have been positioned in appropriate locations. The Ethiopian National Unit is establishing twenty ground teams, and DLCOEA four ground teams, for survey operations. Plans are being concluded for the hiring of additional labor for ground control operations as needed.

In the Somali Republic, DLCOEA and the National Unit are completing plans for ground control operations along the coast of the Gulf of Aden and to the east in the vicinity of Las Anod where scattered but widespread breeding is expected to occur.

In general, DLCOEA and the combined national units in eastern Africa have done a commendable job over the past year. If they continue to operate at the same level of effectiveness over the next several months, the intensity of infestation that can be expected next summer will be substantially reduced from that experienced during the summer of 1968. In the Arabian peninsula, however, the situation is less clear and must be closely watched.

[Excerpted from various reports, July-November 1968, chiefly from the area of DLCOEA. Supplemented by the Report of the Twelfth Session of the FAO Desert Locust Control Committee, Rome, October 1968, No. PL/1968/M/5.]



INFLATION

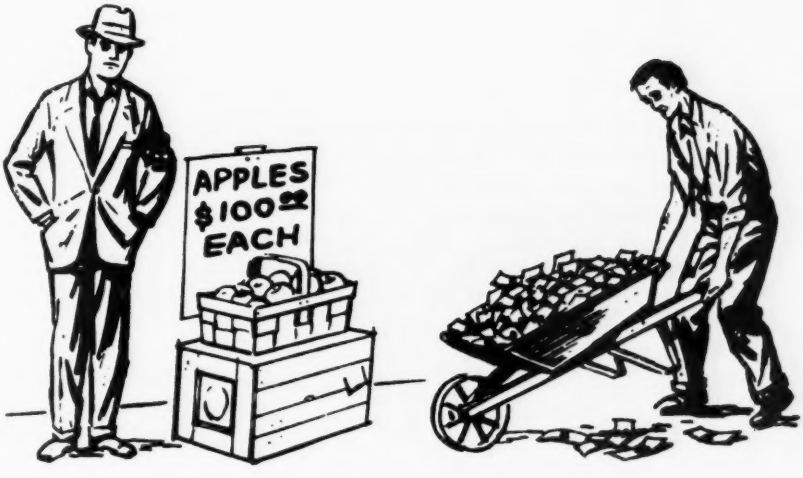


ILLUSTRATION FROM "TAKING THE MASK OFF INFLATION,"
THE FEDERAL RESERVE BANK OF CLEVELAND,
DECEMBER 1967. REPRINTED WITH PERMISSION.

INFLATIONARY PRICE DISTORTIONS AND STABILIZATION

J. J. Polak

[Inflationary price distortions are especially harmful to economic growth. Stabilization, however, is difficult, and often slow; the International Monetary Fund favors certain interim policies to reduce price distortions.]

The causal relationship between inflation and growth is a subject on which it may never be possible to reach agreement. In countries where there is both severe inflation and a lack of economic progress, is the inflation responsible for the lack of progress? Or is the inflation the result of the lack of progress? Or are both the inflation and the lack of progress a reflection of other deep-seated social and political phenomena? We need not, in my opinion, prolong this controversy, because there is apparently broad agreement today—as distinguished from the situation a decade or so ago—on the proposition that avoidance of inflation is favorable to economic development.

Price Distortions

We could perhaps feel reasonably relaxed about inflation from the point of view of welfare and development if it did not more than produce a rise in the general price level. But the inflationary process invariably produces sizable changes in relative prices, and it is the resulting distortions of the price structure that make inflation harmful to economic

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development. There are three very important sets of prices which, in inflationary situations, almost invariably lag behind the general price level.

"Political" prices. This category includes public utility and transportation rates, prices charged by state industrial enterprises, and prices that private producers are allowed to charge under governmental price controls designed to "protect" the consumer. There are many striking instances in Latin America and elsewhere where rates charged for public utility and transportation have lagged behind other prices, and in so doing have undermined the financing of important components of the economic infrastructure. Again, the efforts to hold down, by price controls or by special exchange rates, the prices of popular consumption goods with a heavy weight in the cost-of-living index have been responsible in several inflation-ridden countries for the sorry state of their agriculture.

Foreign exchange. Overvalued exchange rates have hampered the development of badly needed new export industries. They have frequently caused a haphazard development of import-competing industries, because, for lack of the normal protection of a realistic rate of exchange, such industries have been bolstered by the application of import and exchange restrictions, which operate much less systematically. Overvalued exchange rates have led to the exhaustion of exchange reserves, and once having deprived countries of this cushion that can buy them the time required to perform needed economic adjustments, they then have precipitated periodic exchange crises with consequent uncertainties in the economy.

Interest rates. Inadequate or, even worse, negative real rates of interest have discouraged savings in financial forms, and as such have impeded the development of financial intermediaries and capital markets, both of which can play an important economic role in bringing the flow of savings to those who can employ them in investment ventures. In addition, such unrealistic rates of interest are apt to have a negative effect on the level of savings as a whole.

While these distortions are not inevitable accompaniments of inflation, they do reflect very common tendencies in countries suffering from inflation, so much so that it would be hard to point to any such countries where all these problems were not present to some degree. The longer inflation lasts, the more severe are the distortions it tends to produce.

Serious Inflation Often Stubborn

One of the clear facts of life in the postwar experience is that many stabilization plans undertaken have not, or not fully, succeeded.

I do not believe that such failures of stabilization plans should be ascribed primarily to their technical deficiencies. I certainly would not want to suggest that all stabilization programs which the Fund [International Monetary Fund] has supported have been perfect, but I believe that their main thrust has been correctly placed. There has to be some effective restraint of aggregate demand by means of suitable monetary, fiscal, and incomes policies. Without such restraints, there is no hope that inflation may eventually yield to stability. But the willingness to start a stabilization plan is frequently not sustained in the face of the difficult problems which stabilization inevitably presents, and which inflation permits a country to dodge for the time being.

Moreover, it may not always be possible to achieve full stabilization quickly. Severe distortions produced by past inflation pose special difficulties which often cannot be quickly eliminated. Indeed, the difficulties of reaching an effective agreement on the distribution of the social product may not be subject to resolution until sufficient resources have been pried out of the uneconomic sectors. These difficulties have often been compounded because the inflationary period preceding the stabilization plan made very heavy drafts on the country's international reserves and on the ability to borrow abroad.

Interim Policies

In part, the remedy for the underpricing of public utilities involves higher rates for these services. But often the distortions in this sphere of the economy have gone beyond price distortions and require a concentrated attack on the organization of the industries concerned, including complete modernization and a severe reduction in the work force. To perpetuate the uneconomic production of these industries, and to eliminate the resulting deficits by merely allowing very large increases in rates, only makes the solution of the problem of inflation that much more difficult.

With respect to the distortions between domestic and foreign prices, it has been a basic principle of the Fund from the very start of its activity that countries that were unable to contain inflation would be better off not to try to maintain a fixed rate of exchange. In the last ten years or so the Fund has pushed further along this same road, and has suggested to countries that were not able to master the problem of inflation that they adopt a fluctuating rate of exchange and adjust that rate in consonance with internal inflationary developments.

Effective measures are available to minimize the distorting effects of inflation on the attractiveness of savings in financial forms.

Basically, the answer lies in very high nominal interest rates, which in some countries have been ensured by tying deposits and loans to the cost of living. Extremely high interest rates are by no means an attractive feature for any economy. But if a country is unable to resolve the basic issues so as to prevent continuous inflation, it will usually be better off if it prevents at least some of the more glaring economic consequences of this inability than by pretending that the problem does not exist, and maintaining low interest rates and a pegged rate of exchange to further this pretence.

Recognition that full stabilization may not be possible in the short run is no reason for not adopting a domestic policy mix aiming at all times at the maximum stabilization obtainable in the given circumstances. But efforts at a gradual stabilization of the price level have a chance of success only if such price increases as continue to take place are not allowed to produce any more major economic distortions and are useful in helping correct distortions which already exist. Only on this basis can there be any hope that the gradual attack on inflation will eventually yield to true stabilization—a stable price level, a fixed rate of exchange, and relative prices conducive to rapid economic development.

[Excerpted from "Have Economists Said Their Final Word in the Fight Against Inflation?," Finance and Development. Washington (D. C.): International Monetary Fund and the International Bank for Reconstruction and Development, Vol. 5, No. 3, September 1968, pp. 10-12.]

INFLATION IN LATIN AMERICA

Raymond F. Mikesell

[Inflation has been a problem for some Latin American countries in varying degrees. Experience indicates that inflation can be avoided; but if it becomes a "way of life," there may be difficulty in attaining a national consensus on the means for halting the inflationary process.]

The Statistical Evidence

The statistical evidence on Latin American inflation shows great diversity from country to country, including some of the highest rates of inflation in the world along with records of price stability which compare favorably with the United States and Western Europe (see the accompanying table). Three of the more industrially advanced countries—Argentina, Brazil, and Chile—have had high rates of inflation throughout the postwar period. Some of the least developed, e.g., the Central American countries, have had a high degree of price stability throughout. Venezuela and Ecuador have also had stable prices. For others, the record is mixed.

The economic indicator which is most closely correlated with the rate of inflation in Latin America is the rate of increase in the money supply. This applies particularly to countries with high rates of inflation such as Argentina, Brazil, Chile, and Uruguay. For Chile, money supply rose at a somewhat higher annual rate than prices, 38 percent as against 27 percent in 1961-66, but Chile was the only country in the high inflation group that also had a relatively high annual rate of growth in real gross national product

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Latin America: Average Rates of Annual Increase in Prices, Per Capita GNP, and Money Supply
(in percentages)

	Cost-of-Living Index		Real Per Capita GNP			Money Supply
	1950-58	1961-66	1950-55	1955-61	1961-66	1961-66
Brazil	17	60	2.6	3.0	1.2	60
Chile	38	27	.9	1.2	2.6	38
Argentina	22	27	-.2	.1	1.1	24
Bolivia	76	6	-1.1	-1.6	3.6	19
Uruguay	10	40			-.8	39
Colombia	9	15	2.4	1.2	1.4	18
Peru	8	10	2.8	2.7	3.2	13
Mexico	8	2	3.6	1.4	2.7	12
Ecuador	4	2	2.5	1.1	.7	9
Venezuela	1	1	4.6	1.7	1.2	6
Central America:			1.6	.7		
Costa Rica	3	2			.8	6
El Salvador	5	0			2.8	4
Guatemala	2	1			3.0	6
Honduras	3	3			1.6	9
Nicaragua	8	2			5.3	14

(GNP) during the 1960s. Similarly, Mexico's money supply increased at an average annual rate of 12 percent over the 1961-66 period while the rise in the cost-of-living index averaged only 2 percent over the same period.

One of the most significant and controversial issues with respect to Latin American inflation is the relationship between the rate of inflation and the rate of growth in real GNP or per capita GNP. Considering the countries with high rates of inflation during the 1950s, Argentina, Bolivia, Chile, and Uruguay had low or even negative rates of growth in real per capita GNP, while in Brazil real per capita GNP increased more than 2.5 percent per annum. The Central American countries, which have had generally stable prices since 1952, had low rates of growth in real per capita GNP during the 1950s. Other countries experienced varying rates of growth during the 1950s which had no discernible relationship to price movements; nor do we find a consistent relationship during the 1960s.

The Causes of Inflation in Latin America

The monetarist-structuralist controversy. There is a tendency to divide students of Latin American inflation into two groups, the

monetarists and the structuralists. In broad terms the monetarists regard inflation as basically a monetary phenomenon amenable to correction by monetary and fiscal means. The structuralists see both the fundamental causes and the socially acceptable remedies of inflation in the economic and social structure. Individuals rarely conform in all respects to the pattern of the group with which they are identified; hence, the controversy often boils down to a matter of emphasis. However, some of the differences between these approaches are a reflection of differences in underlying economic philosophies.

The monetarist position reflects the orthodox explanation of inflation in terms of the expansion of the volume of money in relation to the growth of real output. The monetarist would insist that substantial and continuous price increases are a direct consequence of monetary expansion, however generated, and that a monetary policy that permits such a state of affairs to continue will create other forces that will accelerate the inflationary movement. Rather than enabling growth to continue in the face of structural impediments, inflation will create new impediments to economic progress—impediments which will feed the inflationary forces by misdirecting output in relation to demand. Finally, the monetarists hold that inflation cannot be contained, or its undesirable consequences long avoided, by government interference with the markets for domestic goods and services or with foreign trade.

Monetarists attach considerable significance to the relationship between inflation and the balance of payments. Excess (inflationary) demand increases imports and discourages exports. Unless the resulting balance of payments deficit can be covered by reserves or capital imports, the country must impose import controls or undergo devaluation, or both. In addition, the high rates of inflation encourage capital flight in expectation of further depreciation, and discourage capital imports.

The structuralists begin by stating that it is not enough to show that inflation is accompanied by monetary expansion. It is necessary to ask such questions as why and by what mechanism did the rise in means of payment occur? What structural factors in the economic process underlie both the price increases and the monetary expansion? It is also asserted that price stability is not a proper objective of economic policy in the sense that stability should be given equal status with economic growth and maximum output or that growth should ever be sacrificed to stability. Stability may be significant only as a means to growth.

The stylized model which appears frequently in the structuralist literature may be summarized as follows. The developing country

is initially in a state of dynamic equilibrium, with output, imports, and exports growing at a rate determined by savings and investment. Then something happens to disturb this dynamic equilibrium; this "something" is almost invariably postulated to be a fall in export earnings. Domestic income and employment would decline unless monetary income is maintained by fiscal deficits and the continued expansion of bank credit to the private sector. However, if full employment and the growth rate is maintained, imports will rise relative to export earnings. Unless external deficits can be covered by foreign exchange reserves or increased capital inflow, import controls must be instituted or tightened, or devaluation must take place. Either course means a rise in the prices of international goods. Fiscal deficits cannot be avoided unless tax revenues are maintained or possibly increased to cover the higher level of government expenditures for maintaining investment and employment. But the revenue system is too rigid to permit a rise in revenues. Food prices rise, but output does not respond because of the structural rigidities that characterize the domestic agricultural system. Wages rise because labor refuses to accept any reduction in real income. As a consequence, prices continue to be pushed up in a continuous spiral.

Most structuralists do not regard inflation as either desirable or as conducive to growth. It is simply a consequence of policies which avoid growth-inhibiting monetary restraints. Nevertheless, the structuralists hold that monetary demand should be maintained. Their position is that the basic solution lies in dealing directly with the structural disequilibrium in output, investment, and consumer demand. This calls for agricultural reform (to make production more responsive to demand and prices), redistribution of income in favor of the lower income groups, tax reforms and other measures to raise the level of savings, redirecting investment in both the private and the public sectors, correcting price disparities through price controls, and allocating foreign exchange in favor of capital goods and raw materials for facilitating domestic investment. Most structuralists tend to favor a rather substantial degree of government control over investment, foreign trade, and the price system.

There are three major difficulties with the structuralist position: 1) several Latin American countries have experienced periods of serious and continued inflation under conditions which do not fit the structuralist model; 2) the structuralist denial of the use of monetary restraint leaves open such questions as the role of monetary policy in developing countries and the guidelines for monetary policy in promoting maximum growth; and 3) many of the structural rigidities which prevent an economy from achieving maximum output from its available resources constitute the very essence of being underdeveloped. Monetary and fiscal policies cannot force growth; but skillful employment of these policies can contribute to the growth

process while the mismanagement of such policies can just as surely inhibit meaningful growth.

Fiscal deficits and bank credit. Fiscal deficits have long been referred to as the principal engine of inflation in Latin America. All of the high-inflation countries have experienced long periods of substantial governmental deficits. A large portion of these deficits are financed by borrowing from the central bank. Expansion of central bank credit constitutes high-powered money, which increases the reserves of the commercial banking system, which in turn can expand credit and the money supply by a multiple of the increase in bank reserves. Some of the fiscal deficits are covered by commercial bank purchases of government securities, but except for those securities sold to the social security system and to savings institutions, little of this financing constitutes genuine savings. The reason is clear when we note that interest rates on government securities are usually less than 10 percent while frequently the annual rate of depreciation of the currency in terms of purchasing power is much higher. Hence few individuals or institutions will buy government securities at negative real rates of interest unless forced to do so by law.

The ever-increasing governmental deficits are in large measure a consequence of the inflation itself and the lack of flexibility of revenues. A large portion of the taxes are excise and import taxes, many of which do not rise in proportion to the increase in prices. Income taxes do rise more or less in line with prices and money incomes; but income taxes account for a minor fraction of Latin American governments' revenues, and few of them are collected currently so that this year's tax receipts are based on last year's smaller money incomes. There is an inevitable lag between revenue and the government's expenditures which must reflect higher current wages and materials costs.

A substantial portion of government expenditures in the high inflation countries goes for subsidies to state enterprises such as electric power and transportation companies. The government is under strong political pressure to hold down rates charged for these services, while increases in the cost-of-living index bring automatic wage adjustments. There is also the desire to increase the real volume of government expenditure each year so as both to meet the demand for social services such as education, and to increase the level of investment in the public sector which accounts for a substantial proportion of the total investment in Latin America.

The expansion of bank credit for the private sector also makes a contribution to the increase in the money supply. Inflation erodes working capital, and a nation needs to expand its money supply to

carry on business transactions as prices rise. Hence the ability to hold down the expansion of credit to the private sector is limited when inflation is being fed by fiscal deficits covered by borrowing from the central bank.

Cost-push versus demand-pull. There is controversy over whether inflation is caused by a rise in wages and other costs pushing up prices (cost-push) or by an excess of demand in relation to supply (demand-pull). It is doubtful whether strong inflation is ever initiated by wage demands in excess of increased productivity or by deliberate increases in prices not justified by wage and materials costs. But once inflation is underway, cost-push factors may limit the ability of the monetary and fiscal authorities to stem the inflationary movement. Urban labor groups with strong unions and political influence are frequently able to raise real wages, including fringe benefits, at a rate higher than productivity. The oligopolistic character of most raw material and intermediate goods markets has enabled producers to push up prices not warranted either by cost or by demand conditions.

Role of exchange depreciation. Exchange depreciation is both a consequence and a contributing factor in the inflationary process. Once internal prices get substantially out of line with external prices, depreciation of the currency becomes necessary both to restore the incentive to export and to encourage the production of domestic goods in competition with low-priced imports. No Latin American country has been able to avoid devaluation over a long period of time in the face of a high and sustained rate of inflation.

Exchange depreciation may contribute to inflation in several ways. It raises internal prices of international goods with direct effects on the price level; and the indirect effects are likely to be much greater. The expectation of a devaluation will also release inflationary forces in the form of speculative buying of commodities whose prices are expected to rise with devaluation, and in the form of capital exports which may reduce exchange availabilities for imports. After the devaluation has occurred there may be a reversal of the speculative forces, especially if the new value of the currency is expected to stick for a time.

The fundamental purpose of devaluation is to bring internal prices and costs in line with external prices. This action is soon nullified however if internal inflation continues. Typically in Latin American countries which have experienced long inflation, the rise in internal prices tends to cancel the initial effect of the devaluation in bringing internal prices into line with external prices. This continues until another adjustment in the nominal rate wholly or partially restores the real exchange rate to its former position.

Social and political factors in inflation. Unfortunately, inflation is more politically acceptable than taxation in many developing countries. Political pressures lead governments to promote development by raising the level of investment in the public sector, but there are political and social constraints on raising tax revenues.

Several students of inflation have suggested that the generation of inflation is largely a psychological and sociological phenomenon. Once inflation is initiated and becomes chronic, businessmen continue to raise their prices in anticipation of higher wage and materials costs. Labor, too, bases its demands on an anticipation of further increases in the cost of living. There occurs a continual tug of war among various economic interests with each advance by one group countered by moves by others. The government is also one of the vested interests in this economic struggle, since in order to maintain the share of government expenditures in the social product it must raise expenditures at a faster rate than its revenues. Government deficits thus become the chief mechanism by means of which the inflationary environment for the economic struggle is maintained.

Government monetary policy provides the environment for this economic struggle since the introduction of monetary restraint would bring the cost-price spiral to a halt only at the cost of a reduction of employment, output, and profits, all of which would create discontent among politically powerful groups. Inflation provides a means of keeping the economic struggle at least partially out of the political arena; in many Latin American countries it has become institutionalized as a way of economic existence.

The Consequences of Inflation

We may summarize some of the standard charges made against inflation as follows:

1. Inflation discourages savings, and the savings that do occur tend to be channeled into inventory speculation, residential and apartment buildings, land, and foreign exchange, rather than into productive industry and agriculture.

2. Shifts in relative prices and in cost-price relationships tend to depress certain industries, such as agriculture, public utilities, and mining, in favor of high-cost industries directed to the production of import substitutes. The price and cost distortions which occur with inflation are in considerable measure due to government price controls.

3. For certain industries at least, increases in wages and other costs, including the cost of imported commodities, rise faster than output prices and therefore reduce profits and the attractiveness of the industries to investors.

4. Government controls over interest rates charged by banks and other financial institutions during inflation result in negative real rates of interest and a rationing of credit which usually results in a misallocation of capital funds.

5. Inflation almost invariably results in overvalued exchange rates, so that production for exports is discouraged and production for domestic use occurs in industries for which the resources of the country are poorly designed.

6. The government's attempts to limit foreign exchange deficits by a variety of import controls further distort the price structure, and this, in turn, contributes to a misallocation of resources.

7. Inflation discourages foreign investment since it creates uncertainties with respect to cost-price relations; leads to an erosion of working capital and to losses resulting from exchange depreciation; and leads governments, as a consequence of foreign exchange deficits, to put restrictions on transfers of such profits as foreign investors are able to earn.

There is considerable evidence for all of these alleged consequences of inflation, although experience differs from country to country so much that the entire list of ailments cannot be considered inevitable.

Conclusions on Disinflationary Policies

1. The avoidance of inflation in Latin America will depend mainly upon the elimination of governmental deficits financed by central bank credits. But given the drive to expand governmental services, this will require a substantial rise in tax revenues, the elimination of governmental subsidies to state enterprises, economies in governmental operations generally, and the creation of a financial system and environment that will both encourage savings and channel them into productive investments, both public and private.

2. Monetary restraint in the form of restricting commercial bank credits to the private sector is likely to be ineffective as a means of controlling inflation, particularly in the absence of appropriate fiscal policies. As prices rise firms require additional liquidity if they are to maintain output and employment.

3. Once an economy becomes the victim of strong and sustained inflation, no simple measures are available for slowing down the rate of inflation given the various economic, social, and political constraints on governmental authorities. It is necessary to deal simultaneously with both demand and cost factors.

4. Despite the importance of decontrolling prices and wages, the existence of monopoly elements insensitive to demand patterns and the large role played by expectations suggest the need for some degree of governmental intervention in halting an inflationary spiral by minimizing increases in costs and avoiding price rises not justified by increased costs. The formula adopted for adjusting government wages and salaries and legal minimum wage rates should be altered so as to reduce the rate of rise in wages well below past and current rates of price increases. Wage adjustments should take place only at long intervals, say 18 to 24 months. Such actions would need to be accompanied by the control of key prices, and perhaps special taxes on business. This would of course create inequities, but so does inflation.

5. Stabilization efforts should include measures for expanding real savings. Until confidence is restored in money as a store of value, savings deposits, government securities, and other debt instruments should be adjusted in value to changes in the cost-of-living index. It might also be desirable to pay a portion of automatic salary increases to some groups in non-negotiable bonds or in the equities of the corporations employing them.

6. A stabilization program should begin with a once-for-all devaluation based on a realistic estimate of a rate of exchange which will be compatible with long-term equilibrium (including the adjustment of disparities between internal costs and external prices) after prices have been stabilized. It might be better in this connection to err on the side of undervaluation since the stabilization program should include the elimination of most import restrictions and the adoption of an open economy.

7. A program of stabilization and the removal of price disparities should include the establishment of an open economy with the elimination of quantitative trade controls. There should be a drastic reduction in import duties looking toward a reasonable level of protection to be established by the common tariff on imports under the proposed Latin American Common Market.

The Role of External Agencies in Limiting Inflation

Latin American inflation has presented vexing and frustrating problems for external assistance agencies. Over the years the

Agency for International Development (AID), the International Monetary Fund (IMF), the International Bank for Reconstruction and Development (IBRD), and the Inter-American Development Bank (IDB) have employed various strategies. These include: cooperating with stabilization programs; making aid conditional on particular stabilizing measures; actually suspending aid in a few cases; in other circumstances, ignoring the whole issue (e.g., for IDB project loans).

Countries can be assisted in preventing the generation of inflationary forces arising from foreign exchange shortages. Countries can also be assisted in carrying through a determined stabilization program by enabling them to liberalize imports until the removal of price disparities and the establishment of a realistic exchange rate have had their effect upon the balance of payments. External assistance agencies can also provide advice and exercise a certain amount of influence on governmental policy in support of the proponents of stabilization. However the role of external agencies in controlling inflation is severely limited in two important respects. First, external assistance alone, no matter how generous and timely, can do little more than modify temporarily the progress of an inflationary spiral. And, second, the promise of aid, or the threat of its withdrawal, will not be an effective instrument for getting governments to take and enforce for an extended period unpopular measures that they would not be willing to take in any case.

Stabilization must, in the end, come from within. The success of a stabilization program may sometimes call for more than strong will on the part of the government; it may require a social compact on the part of the contestants for the shares of the social product to accept certain restraints. This in turn implies a broad consensus on the part of the public and of various power groups that inflation is an evil which must be eliminated—a consensus that may be difficult to produce in a country where inflation has become a way of life.

[Excerpted from Survey of the Alliance for Progress: Inflation in Latin America. A study prepared at the request of the Subcommittee on American Republics Affairs of the Committee on Foreign Relations, United States Senate. Washington (D. C.): U. S. Government Printing Office, 25 September 1967, pp. 2-24 and 36-39.]

PROBLEMS OF THE INDONESIAN INFLATION

J. A. C. Mackie

[Indonesia probably had, until recently, the world's most rapid inflationary rate short of hyperinflation. This article, written in 1967, treats certain problems that were posed in acute form: How does an economy get by without "collapse?" How can individuals on fixed salaries cope with continuous price rises? How do business enterprises fare?]

Indonesia has experienced almost continuous inflation since the Japanese overran the Dutch colonly in 1941. Not only in its length, but also in its intensity during the last few years, Indonesia's inflation has come to rank among the outstanding examples of this phenomenon in modern times. Her transformation within less than 20 years from a colony geared to one of the hardest currencies in the world into an independent nation with one of the weakest has set in train profound social and political changes whose end is not in sight.

Since 1949, when the Dutch surrendered full sovereignty to the Republic of Indonesia, the inflation has passed through four distinct phases. In the first period, until the end of 1956, inflation was a persistent and serious problem, but was largely due to abnormal circumstances so that there was no reason to fear that it could not be curbed. In the second period, however, from early 1957 to late 1961, both money and prices increased at an average rate of about 30 percent per annum, as the government virtually abandoned budgetary stability while it concentrated on the more pressing task of crushing regional revolts in

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Sumatra and Sulawesi. Inflationary pressures did not get entirely out of hand in this period; in fact, an impressive degree of stability was achieved in 1960 after the government had taken draconian measures. But another sharp rise in the rate of price increases in late 1961 ushered in a third phase of inflation through 1961-64, during which both the volume of money and the cost of living roughly doubled every twelve months. When the price rises again accelerated sharply to an unprecedented rate in the last quarter of 1964 (both prices and money almost doubling between December 1964 and June 1965) a new and dangerous phase of inflation began. [Note: the inflationary peak year was 1966, when the cost of living rose 650 percent; in 1967 the increase was 125 percent.]

Essentially, Indonesia's inflation has been characterized by a steady increase in the volume of money in circulation, which has been accompanied by roughly corresponding increases in prices, since production of goods and services showed hardly any increases in this period. (National income rose by an estimated 9 percent from 1958 to 1962, as did population, with major food crops showing a slightly greater increase but with declines in the industrial and estate sectors.) The government's budget deficit has been, without any doubt, the main cause of inflation; bank credit had a relatively minor influence on the money supply. Despite increases in government spending, however, the government's share in the national income has fallen: government expenditure and revenue were both over 10 percent of the gross national product (GNP) in 1960; but by 1965 they were estimated at only 3.5 and 1.5 percent respectively.

Obviously, many factors have contributed to Indonesia's poor record of economic performance. I stress one of them, the relative weakness of her governments in most areas of economic policy-making, because I believe that the political weaknesses of Indonesian governments have been at the root of most of the country's economic troubles since 1957, despite their outward display of authority and strength. The government's resort to deficit financing since 1957 was, in effect, a means of putting off decisions of a politico-economic nature which might have caused dissension between elements within the government. A political balance was maintained, precariously at times, at the cost of economic equilibrium.

Until the parliamentary system began to crumble in 1957 and give way to the presidential system which took shape in July 1959, political parties were the key elements in the Indonesian political system and the relationship of the government to the Parliament was not outwardly very different from that of any orthodox parliamentary democracy. After the establishment of the presidential system, in which the two representative bodies had virtually no real power to curb the President and his ministers in their day-to-day administra-

tion, the key elements in the political system have been very different. Perhaps I can best summarize the processes of government under Sukarno's "Guided Democracy" with a quotation from Feith:

> . . . this is not a government which can easily exert much weight of power. Many of its decrees are effectively ignored by those who are charged with their implementation. This is sometimes attributed to the ineffectiveness of its administrative machinery. But it is more accurately described in terms of the weakness of the political elite's cohesion, the heavy dependence of this elite on the bureaucracy as a social class, and the great importance of intra-bureaucratic politics as a force for immobilisation of the government.

The "Resilience" of the Economy

How is it that an economy which time and again has been described as being on the brink of collapse has proved able to put up with shocks and strains which would have been ruinous in most countries? "Indonesia defies the rules of conventional economics" we are sometimes told by Indonesians who take perverse pride in their feat of survival.

Food production has been rising (slightly, and all too little) during the past decade. It is mainly the urban and monetized sectors of the economy which have deteriorated. The inflation has wrought serious damage to the entire economy, for there are many signs of severe deterioration in the country's basic capital stock. But nations do not "collapse" in the sense of going bankrupt, like private individuals or companies. They may run short of foreign exchange, as Indonesia has, even to the point of repudiating their debts; and their governments may resort to deficit financing because they are "living beyond their means." However, they can carry on for some time without reaching a breaking point.

Part of the explanation appears to have been that there was more Indonesian foreign exchange in reserve than the official figures revealed, much of it in illegal private accounts abroad, so that the situation was not as desperate as highly colored reports indicated, until at least the end of 1964. Indonesia is nearly self-sufficient in foodstuffs (and could quite easily become so if a few simple agricultural changes could be effected), and continued to earn sufficient foreign exchange, despite the economic disruptions of 1957-65, to pay for essential imports. She is very far from self-sufficient in most manufactured goods but, until 1965 at least, there was still ample scope for belt-tightening on imports without creating intolerable hardships for the people or immediate disruption of the national economy.

The alleged resilience of Indonesia's economy is often related to the observation that everyday life goes on, particularly in the rural areas, in much the same way as it has for decades, despite the alarming depreciation of the currency and the running down of basic services. This notion is frequently linked to the fact that the vast majority of Indonesians, nearly 85 percent, live in rural villages, supposedly self-sufficient and independent of the monetized economy. Peasants who grow foodstuffs and sell part of their crops for cash have been cushioned against price rises to some extent by the fact that their cash incomes have risen also. (Whether they have risen commensurately with the prices of their consumption goods deserves closer investigation.) We therefore tend to assume that the rural population has not suffered from the inflation as severely as town-dwellers and civil servants on fixed income.

Inflation brings one great benefit to the poor, of course—it tends to reduce the burden of debts, since money values have depreciated by the time they are repaid. For example, the immediate postwar inflation relieved many peasants of long-standing debts to Chinese money-lenders. But this kind of windfall benefit will not be repeated often before interest rates are raised by the creditors. Higher interest rates and reduced availability of credit seem to have been accompaniments of Indonesia's recent inflation, and while these are not helpful to the peasant, they are less burdensome than an inexorable rise in indebtedness.

In sum, a largely rural population, a continuing though hardly generous supply of basic necessities, and a mild, even climate, are the main protective factors. There is also an element of adaptability; people can make do with remarkably little in Indonesia, as they did throughout the Japanese occupation. Yet these things do not mean that Indonesia has some peculiar immunity to the consequences of inflation, merely that her economy has been well cushioned to withstand and adjust to the initial impact. It is important that this matter should be seen in perspective, for Indonesia cannot afford to tolerate economic deterioration indefinitely without experiencing the compounded effects of many adverse tendencies.

Another puzzle about Indonesia's inflation is that people have not lost confidence in the currency to the extent of rushing to buy goods in order to get rid of their Rupiahs before they depreciate further in value. Firms and wealthy people do buy goods as a hedge against price rises, of course, as do those with middle incomes, and the velocity of turnover was increasing [through 1966]; but it has generally not accelerated as fast as one might have feared. Here the contrast with China's inflation in the later stages seems noteworthy. Two explanations may be offered: For the poor, there was relatively little saving in money form at any time and thus little scope

for changes in behavior. On the other hand, wealthy Indonesians often hold surprisingly large cash reserves—usually in their homes, rarely in bank accounts, where they can be investigated too easily. The opportunities to make large windfall profits if one has a ready store of liquid funds are lucrative enough to outweigh the losses through depreciation. Prices move very unevenly in different sectors of the market at different times, leaving openings for alert speculators.

How Do People Survive?

How do individuals in the towns and cities cope with the continual price rises when they are fixed-income employees, and particularly civil servants? For merchants or pedlars or pedicab-drivers, rising prices being at least some increase in incomes. They have suffered hardships too, of course, but more from the unevenness of price changes and the disruptions of supply caused by inflation than from inflexibility of their cash incomes. However, an index for the earnings of factory workers, compiled by the Ministry of Labor using 1958 as 100, showed real values of 32-44 in 1962-64; such values for government employees would be still less. Available figures indicate that for some years before 1965 a single government salary was not enough to sustain a man with a family, or even a single man or woman in most circumstances. Somehow, supplementary sources of income had to be found.

One of the most obvious and common ways of increasing the family income, of course, is to put one's wife to work. In fact working wives are very numerous at almost all levels of Indonesian society, from wives of senior officials to shopkeepers and servants, and also in the countryside. Sometimes the family will be a large one, with several children or relatives contributing to the household expenses. Moreover, relatives will often help each other to a greater extent than in more individualistic societies. Or a town-dweller might retain some property or familial ties with his village of origin and frequently obtain rice or other foodstuffs from it at little or no cost.

The most straightforward way for civil servants to supplement their incomes has been to take several jobs. Many government employees will divide their week between several different jobs, drawing a salary on each and often spending relatively little time at any one office. Absenteeism has become a major impediment to office efficiency, but it is not easy for the government to take effective action against it. Some of the middle-ranking government servants may have jobs as bookkeepers, teachers or petty businessmen; the lower ranks may resort to jobs as nightwatchmen, chauffeurs or even pedicab-drivers. And directorships or consultative posts with private firms, which will pay handsomely for the contact, are not uncommon among higher officials.

Travel allowances have served as a substantial source of supplementary incomes for some civil servants. Senior officials who travel abroad frequently on official business can do very well by saving as much of their foreign exchange allowance as they can, with which either imported goods or black market Rupiah can be purchased. Only a small proportion of civil servants have opportunities for foreign travel, of course—though the number who managed to get themselves sent abroad on some training course or other used to be astonishingly high; some official junketing tours have been blatantly scandalous.

Corruption and malfeasance in their many manifestations—whether in the form of accepting bribes, misappropriating government funds or property, taking commissions on contracts or margins on official purchases, requiring "presents" to perform some official service, even simply stealing paper and pencils from government offices—constitute another whole range of methods by which many civil servants are able to supplement their incomes. There seems to be no doubt that corruption is now far more widespread than it was six or eight years ago, and press reports of the court cases reveal new and ever more ingenious forms of malfeasance. "We are compelled to do many things we are ashamed of," said one young civil servant in reply to the author's question about his income; he was a devoted and serious middle-ranking official whose position would not in itself create particular temptations to malpractice and who had deplored such behavior a few years ago when there was less justification for it.

Insofar as most wage and salary earners are paid at least a part of their income in kind, they are cushioned to that extent against price increases. Rice, universally, and for some groups sugar, kerosene, soap and cloth have been made available to State employees in varying quantities, at artificially low prices, from time to time for over a decade. Many private firms also try to provide at least rice, as well as annual bonuses (usually cloth), which are now almost obligatory. Very cheap housing is another real income subsidy that many salaried civil servants enjoy, but rarely the lower-paid wage-earners. Those who are buying the government houses they occupy on terms that were laid down as far back as 1950-51 may be paying as little as Rp. 250 per month over 20 years for houses worth several millions by 1963. Frequently they will squeeze in a large number of relatives or lodgers whose contributions are not subject to rent control. Official cars have, at times, also been purchasable by very senior civil servants and ministers at unrealistically low prices. The importance of the real wage component in a civil servant's wage has increased over the years as cash incomes have depreciated. In the early 1950s it was a matter of secondary concern for most of them, but since about 1959 it has become a prominent political issue.

Business Enterprise under Inflation

In an inflation, profits are increased as a component of national income relative to wages and rents. Hence the rich—some of them, at least—get richer, while others besides the poor get poorer. In Indonesia, since the intensified inflation, the well-to-do enjoy luxuries which seem incredible to an outsider, and control funds of a magnitude which would have seemed out of the question ten or fifteen years ago. But others have fared badly; not enough is known about the impact of inflation on business firms to permit bold generalizations about bankruptcies, changes of ownership, or the ways in which firms which have survived managed to accommodate themselves to adverse conditions. The capriciousness of government policy and constant uncertainty of raw material supplies, prices and availability of liquid funds have been the most damaging accompaniments of inflation, for they have forced businessmen to become hoarders and speculators.

The tragedy of the Indonesian economic system has been that uncertainty about the future has made speculation an almost inevitable part of every cost calculation, and blurred any sharp distinction between illicit hoarding and legitimate anticipation of future price levels. It has also put a premium on quick turnover and the almost-assured profits of trading on a constantly rising market, rather than the uncertainties of investing in manufacturing or slow-yielding forms of production. (Growing rubber trees, for example, declined whereas tobacco experienced quite a boom.) Even manufacturers have had to become speculators to some extent when uncertainties in the supply of essential materials disrupt their productive activities. Shortages of clothing and other necessities have not had the effect of encouraging domestic production in Indonesia. Instead, domestic production has declined because the circumstances creating those shortages have encouraged speculation and discouraged productive investment.

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BRAZILIAN INFLATION

Mário Henrique Simonsen

[The Brazilian experience challenges many traditional ideas about the consequences of inflation. For some 15 years the country supported a high rate of growth in real product despite continuous and steep price increases. Nevertheless, Brazil's experience does not provide evidence that a continuous rise of prices is favorable to development.]

Brazil suffered sharp inflation during World War II along with much of the world. After a brief period of restraint, prices again began to soar in 1950 at an annual rate of about 17 percent. It was in 1959 that Brazilian inflation really broke into a gallop, the proximate cause being the government's abandonment of a promising program for monetary stabilization. Between January and December of that year, the general index of wholesale prices spurted 36. 1 percent. In 1960 the rate of inflation fell off a little; the price rise for the year was 25-30 percent. But in 1961 it shot up to 40-50 percent, and in 1962 to 50-60 percent.

In 1963 the process was further aggravated. The government first tried a stabilization program that was aimed at restraining demand but neglected price controls; the program was then dropped. Meanwhile, the deficit reached a new high as wages climbed with government encouragement. That year prices rose 80 percent. During the first months of 1964, the final period of João Goulart's government, the price

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rise was no less than 25 percent. At this rate, inflation, geometrically projected, would have come to 144 percent per year.

The Castelo Branco government, immediately after taking office, put into effect a well-conceived program aimed at gradually restraining the inflationary process. The program was not fully successful: the actual inflation rates exceeded by far the official forecasts; nevertheless, the restraining policies of the government were able to reduce the price rises to about 40 percent a year in 1965 and 1966.

Social and Political Roots of Inflation

The root of Brazilian inflation lies in the government's distributive policy. Each social group is dissatisfied with its participation in the national product; in order to quiet this discontent, the government seeks to divide the product into parts the sum of which is greater than the whole. The operation of this mechanism requires certain cultural and political conditions. There must be a general lack of sophistication concerning the causes of inflation, a situation likely to exist in less-developed countries. In Brazil, although the masses abhor continual price increases, there is no popular outcry against budgetary deficits. Politicians must be willing to go along with the popular view out of ignorance or expediency. Although inflation discredits governments, it is equally true that a demagogue wins easy popularity by ordering increases in wages and public expenditures.

Once inflation gets going under these circumstances, it is difficult to contain, harder to stop. Each group, hurt by price increases, clamors for a return to its original position. The government accedes. What normally occurs, in individual cases, is an oscillation of real income. In the case of wage-earners, nominal wages are adjusted only intermittently while prices rise continuously. Immediately after each readjustment, wages reach a peak; from then on purchasing power begins to decline until the next readjustment, when wages reach a new peak, and so on. From an aggregate standpoint, oscillations in the real income of different groups virtually offset one another. When some groups are at their real income peaks, others are down in the valley, while still others are half way up.

The previous peaks of purchasing power, however transitory, become a yardstick that few individuals will relinquish. A sort of mystique gathers around these previous peaks; they represent the minimum distributive justice that each one has a right to expect. This, then, is the fertile group in which the direct causes for Brazilian inflation—uncontrolled public deficits, rapid monetary expansion, and disorderly wage adjustments—flourished.

The Federal Public Sector and the Money Supply

One of the main causes of Brazilian inflation has been the violent pressure of the federal government's deficits on the monetary system. Until 1955 the federal government was not a main cause of inflationary pressures; the monetary expansion derived to a greater extent from the expansion of loans by the banking system to private enterprises, government corporations, and state and municipal governments. Starting in 1956, however, the federal government became the main force behind inflation. In 1955, the cash deficit was only 0.8 percent of gross domestic product (GDP); it rose to 2.2 percent in 1956 and reached 5.1 percent in 1963.

The reason for the rapid real growth of the federal deficit is to be found in increased expenditure; it averaged 9 percent of GDP in the ten-year period from 1945 to 1955 but rose to 14.6 percent in 1963. Public revenues increased slightly as a percentage of GDP, but did not keep up with the expenditure increases. The accelerated increase in federal expenditure stemmed from three main factors: 1) The spoils policy in the public sector padded payrolls and forced successive increases in salaries. 2) There were continuous increases in public investment due to the vicious cycle of inflation. The government increasingly found it necessary to invest in certain sectors of the economy as private capital withdrew, either exhausted by inflation or discouraged by price controls in these areas. 3) There were growing deficits in government corporations and in the so-called "mixed" companies (government and private capital), particularly in the railways and merchant marine.

The money supply in Brazil has been growing in recent years more or less in proportion to the general increase in prices plus the increase in the real product. Between December 1947 and December 1966, the money supply increased 223 times. By comparison, the general wholesale price index rose 131 times, the difference being due to the growth of the real product and, to a smaller degree, to the variations in the income-velocity of money.

The Credit Market in Inflation

In examining the credit market, we touch on a very interesting phenomenon—the way in which Brazilian institutions have adapted themselves to inflation. The credit market has developed very complicated devices to circumvent legal restrictions. And these evasions have exerted a certain stabilizing effect on the credit market, reducing to some extent the gap between demand and supply, by mobilizing savings that would not otherwise have been available—though it is true that shortages have persisted, particularly in the area of long-term credit.

In Brazil, a 1933 "Usury Law" prohibits loan contracts with interest rates of more than 12 percent a year. Though this is certainly a very high rate during periods of monetary stability, it becomes ridiculous when the inflation rate reaches 50 percent or more. One way to adjust to the problem would be to introduce an escalator clause in loan contracts, in accordance with some agreed-upon price index. But the Brazilian gold clause law of 1933 specially forbids this, and up to now no one has found a legal loophole. However, the barriers of the Usury Law have been wholly surmounted by several devices, sometimes in combination: under-the-table interest (charging extra interest without any accounting entries either in the bank's or the borrower's books); overcharge of banking fees (the bank charges the borrower for opening the account, for collection of bills, etc., at inflated fees); and linked accounts. This last device—the most sophisticated of the three—consists of tying a loan to a time deposit until the debt is paid off. The borrower takes out a loan much larger than he needs and deposits part of this money in the bank. Since the interest rate paid on such deposits is far less than the rate charged for the loan, the effective interest rate is far above that appearing in the contract.

Medium-Term Credit. The demand for this type of credit has increased extraordinarily in recent years with the development of the consumer durable-goods and capital-goods industries, especially the automobile industry. These industries, in order to broaden their markets, had to turn to installment selling on terms up to 18 or 24 months; but commercial banks, because they were unable to attract time deposits, were not in a position to grant medium-term loans. After a certain period of difficulties, the problem was solved by the so-called "credit and finance companies," through the use of some perfectly legal devices which were successful in attracting medium-term funds equivalent to time deposits.

The first method consists of substituting participation-account partnership contracts for deposits and loans. In the formation of a participation fund, the finance company itself is the open partner and time depositors are the hidden ones. The resources of the fund are then used in new participation-account partnerships, in which the borrowers of the company are the open partners and the fund is the hidden one. Deposits and loans take the name of participation-account partnerships and the interest rates take the name of profits; this change of words allows escape from the Usury Law regulations.

The second system, employing bills of exchange, is even more ingenious. The borrower exchanges promissory notes for bills of exchange drawn by him and accepted by the finance company. The finance company assures the payment of the bills it has accepted through the previous falling due of bills received by it. Since the

bills of exchange are considered as securities, it is possible to sell them at a discount in the capital market; thus, the borrower gets the money he requires. A one-year security that is resold for 74 percent of its nominal value assures the purchaser an implicit interest of 26/74, or 35.1 percent per year, and the borrower indirectly pays this implicit interest rate.

The Coexistence of Inflation and Development

Between 1947 and 1961, notwithstanding the chronic increase in prices, the country's real product rose at an average rate of 5.8 percent per year—one of the highest rates in the world during the post-war era. Per capita real product expanded at an average of 3.0 percent per year. More surprisingly, there was no slowdown in development rates even when inflation was accelerated from 20 percent to 40 percent a year. On the contrary, between 1957 and 1961, total real product managed to grow at a rate of 6.9 percent per annum.

Of equal interest is the excellent capital/output ratio during the inflationary period. According to the estimates of Fundação Getúlio Vargas, the average rate of gross capital formation from 1947 to 1960 equalled 16.6 percent of gross domestic product. Correcting this to account for fixed capital depreciation, estimated at 5 percent of GDP, we would have a net investment of 11.6 percent. Comparing that rate with the 5.8 percent, the yearly average growth of the real product, we may conclude that the incremental capital/output ratio would have been equal to 2.0 on the average—a high index of investment productivity. In the last years of the 1947-61 period, while the investment rate declined the growth rate of the real product increased, i.e., there was an improvement of the capital/product ratio, precisely during the most intense period of the inflation. Estimates of capital formation in Brazil are not entirely reliable; nevertheless, it seems irrefutable that Brazil managed, until 1961, to reconcile a high inflation rate with a relatively high level of capital formation and an excellent capital/output ratio—something that many orthodox thinkers would not have predicted.

The breaking of the pattern in 1962 and the recession of 1963 and 1964—when the inflation rate hit 80 percent a year—may restore some confidence in the traditional ideas. However, one may doubt whether the recession was the result only of the increase in prices. Drought in some areas and frost in others hurt crops; seasonal factors forced the rationing of electric power, which cut back industrial production; strikes and social agitation, openly encouraged by the government of the period, undoubtedly discouraged investment and impaired the country's production. Thus, it would be too simple a solution to pin the main blame for the economic recession of those

two years on the inflationary rate. Nevertheless, even if we assume that the possibilities of coexistence of inflation and development had been exhausted, the question still remains how coexistence managed to persist until 1961. Some of the answers are:

Contrary to the traditional assumption, Brazilian inflation discouraged rather than encouraged the purchase of real estate. This was basically due to: 1) the continuance of a lease law that half-froze nominal rents and made investment in rental housing extremely unattractive; and 2) the atrophy of mortgage credit money as a result of the Usury Law, which greatly restricted home-building. An enormous housing crisis exists now in Brazil, accompanied by a growing proliferation of slums. This socially painful situation was, however, associated with a lowering of the capital/output ratio for the economy as a whole since a high ratio item was compressed in the investment list.

One may also doubt the effect in Brazil, on a significant scale, of the traditional hypothesis that inflation encourages overaccumulation of inventories. While there is no sure evidence that can be brought to bear on this, it is worth noting that in recent years the value of corporations' inventories in Brazil has been growing less rapidly than the general wholesale price index.

Price controls that might have distorted production and investment simply failed to work. If food price control had been carried out too strictly, it would seriously have discouraged agricultural production as occurred in Chile. However, these controls were no more than a mere tactic, the chief effect of which was to check a continuous price rise in stages. Along the same lines, the economy greatly benefited by the evasion of the Usury Law through overcharges, participation partnerships, etc.

The government started to cover those sectors of the economy that ceased to attract private capital because of inflation; as these areas were continually expanding, governmental investments began to dominate an increasingly larger portion of the country's capital formation. Estimates of government participation, not taking into account mixed corporations, rose from 25.9 percent in the four-year period 1947-50 to 37.1 percent in the four-year period 1957-60. No consolidated data on the investment by mixed government-private companies are available before 1956, but if these companies are included, the governmental sector accounts for 47.9 percent of fixed investments in Brazil in 1957-60. There are strong indications that from 1960 onward government's domination of investment has increased, and that the various sectors of the government and their companies now account for almost two-thirds of the country's capital formation. From the standpoint of long-term development, one may

ask if this socialization of investment will not be harmful, because of the government's inefficiency. In the short run, however, this increase in the government's share of investment surely avoided the bottlenecks that inflation would have created.

These are some of the factors that explain how Brazilian inflation, until 1961, proved capable of coexisting with a high rate of economic development. By no means should these observations be construed as enthusiasm for the country's inflationary experience. All that has been proved is that development may be consistent with prolonged inflation—but not that there is any positive correlation between the two. In fact, Brazil offered an interesting example of how inflationary distortions can be counter-balanced, though at the cost of regrettable sacrifice. The same results, with less sacrifice, could probably have been reached through an orderly policy of economic development.

[Excerpted from "Brazilian Inflation: Postwar Experience and Outcome of the 1964 Reforms," Economic Development Issues: Latin America. New York: the Committee for Economic Development, Supplementary Paper No. 21, 1967, pp. 265-273, 282-285, and 301-315. Also available in hard cover by Frederick A. Praeger, Publishers, New York.]

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